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SOCIAL INTERACTIONS AND TRANSMISSION OF KNOWLEDGE

UNIVERSITE DE NEUCHATEL

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Introduction

Anne-Nelly Perret-Clermont
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The aim of this symposium 1) is to draw attention to an important process in cognitive development and in social life i.e.: the transmission of knowledge, and to better understand how this process occurs in individuals and in small groups and how it can be helped through school teaching.

There is no need here to recall the importance for a given society or culture to transmit to its children the knowledge that organizes its technical, economical, philosophical and social practices. Nor is it necessary to recall the growing consciousness, in recent years, of the importance of the individual's autonomous intellectual growth. Yet these two aspects are only seldom being considered together:

1) - either because the focus of the researcher's attention is on the individual's mind (stages of development, functioning, structures and other characteristics). The mind is then considered in itself, out of context, as if the mind could develop without confronting itself with other minds productions (discourses, sollicitations, writings, judgments, etc...).

2) - or because all the attention is placed on the teachers activities (discourses, pedagogical objectives and strategies, etc.) as if, given children with the necessary capacities and motivations, the teacher's knowledge could be deposited as such in the pupils' minds and appropriated by the learners independently of their other ongoing activities and needs.

The contributors to this symposium show how interesting it is to overcome the temptation of these oversimplifications and to unravel the very precise and sometime minute mechanisms that allow for the double process of transmission and appropriation of knowledge. In the light of some of the results presented here it will appear that,

1) Some of the contributions presented here were first discussed in a symposium on "Social Interactions and Knowledge Transmission" held in Rome, Italy, on September 10-13, 1986, during the II European Conference on Developmental Psychology of the International Society for the Study of Behavioural Development.
far from being only an intellectual (and a priori rational) affair, the giving and seeking of knowledge is also a sort of psychological fight for mutual understanding, identity, mastery and interpersonal prestige or power. And yet, this fight (or "sport" or challenge or work) seems to have to obey certain rules if not the matter at stake is no more knowledge and cognitive growth but dilutes into banal quarrels and misunderstandings. If this occurs then what is "learned" is no more the knowledge that was supposed to be transmitted but distorted understandings, stereotyped mental and social strategies, memorizations void of meaning etc.

The rules that gear the proper transmission of knowledge in a social interaction are complex and usually we are not conscious of them. Often, even, our philosophical and pedagogical preferences somehow prevent us from seeing their display in the teaching/learning interactions that we observe. This is why the research that will be presented here innovate with new theoretical and methodological approaches to try to apprehend this reality.

The transmission of knowledge occurs in a context that can be considered as containing different levels of reality (like the traditional Russian dolls that fit one into the other):

1) Psychological level
On the psychological level one can observe how the teacher's understanding of the content of the lesson influences his/her discourse. But the teacher's apprehension of the pupils' behaviours and attitudes also influences the way in which he/she will transmit his/her knowledge.
On the psychological level as well, cognitive psychology has illustrated the ways in which children's understanding develop and becomes sensitive to different types of adult contributions. Cesar Coll addresses this question for curriculum design and teacher training.

2) Psycho-social level
But this psychological functioning of the individual teachers or student is not independent of the social relationships in which it is embedded. The students intellectual attitudes are modified by the teachers interventions. This is illustrated by Nancy Bell and Michèle Grossen's observations of adult-child communication in a testing situation.
Likewise teachers representations of the learners possibilities are modified if they learn to observe the intellectual and social strategies at work during the teaching/learning sequences.
On this psychological level one can observe the multidimensionality of the teacher-pupil relationship: intellectual discourse but also socioemotional processes gear the exchange of ideas and judgements. The discourse is concerned with knowledge but also with social roles and self assertion. Maria-Luisa Schubauer-Leoni presents empirical illustrations of implicit assumptions and struggles in the teacher-pupil relationship.
Also on this psychological level, observations of peer-peer interactions in the classroom point to the similar multidimensionality of inter-pupils relationships. Likewise they have a role in the teaching-learning process. Cristina Zucchermaglio presents detailed observations of such processes in early literacy development and report how teacher's behaviours can bring support to their occurrence for better learning. Margherita Orsolini and Clotilde Pontecorvo also address this question and illustrate the various forms and functions of cognitive interaction in small working groups in a classroom. Their observations suggest that thinking is rendered possible (or encouraged) through specific types of interventions by the teacher. One learns to reflect.

3) Social and cultural level

This brings us a further level of reality: the wider institutional and cultural context in which the social relationships just described take place. The school is a prestructured social and cognitive environment. Cesar Coll addresses the question of curricula and reflects upon the conditions that have to be fulfilled for the true meaning to be conveyed. Maria Luisa Schubauer-Leoni shows the impact of the predefined social roles on the interchange of information. Clotilde Pontecorvo and her colleagues illustrate how social and cognitive roles emerge in learning groups.

The knowledge transmitted is also prestructured. This is already obvious in the study of literacy. But this "prestructured nature of knowledge" becomes a physical reality when considering technical tools. Jacques Perriault's contribution considers the problems of transmitting technical knowledge. The transmission of a particular body of technical knowledge, for instance computer science, can be concordant, and perhaps more often discordant, with the practices and values of the institutional and cultural context in which it is transmitted. The observation of the interaction between the transmission and the setting can open the way to new adaptations of the social relationships as well as of the technical tool. Perhaps a computer is not as "prestructured" as it might seem in first instance...

Knowledge transmission is a very complex process. We hope that the present symposium will help moving ahead in its understanding, and stir new research developments. This area is of vital importance in a world in which social relationships, knowledge, and technical practices are growing in complexity and interdependence.
THE IMPLICATIONS FOR SCHOOL CURRICULUM OF AN UNDERSTANDING OF KNOWLEDGE AS GENERATED WITHIN A FRAME OF INTERPERSONAL RELATIONS.

César Coll Salvador

Universidad de Barcelona


INTRODUCCION

En el capítulo de las aportaciones que ofrece el análisis psicológico a la elaboración y desarrollo del Curriculum Escolar, se suele insistir en las que se refieren a los procesos de aprendizaje y desarrollo del alumno. Esta insistencia está totalmente justificada si se tiene en cuenta que dichas aportaciones repercuten de forma decisiva sobre la práctica totalidad de los elementos del Curriculum: ayudan a seleccionar contenidos y objetivos; proporcionan criterios para establecer secuencias de aprendizaje; y contribuyen a tomar decisiones sobre la manera de enseñar y evaluar. No cabe ninguna duda de que toda propuesta curricular es tributaria de una determinada manera de entender los procesos de aprendizaje; e inversamente, de que concepciones distintas del aprendizaje escolar dan lugar a propuestas curriculares netamente diferenciadas.
Se tiende, sin embargo, con excesiva frecuencia a identificar un tanto mecánicamente los procesos de aprendizaje y desarrollo, de naturaleza esencialmente personal o individual, con los procesos instruccionales y educativos, que se sitúan más bien en el ámbito de lo interpersonal o interindividual. Todo sucede como si del análisis de los procesos psicológicos que intervienen en el aprendizaje escolar y en el desarrollo individual pudiera deducirse unívocamente la manera de incidir o de influir sobre ellos con fines instruccionales y educativos.

Este planteamiento es, en mi opinión, incorrecto. Ciertamente, la concepción del aprendizaje escolar y la concepción de la intervención pedagógica que contribuyen, desde la psicología, a articular una propuesta de Curriculum Escolar son dos aspectos íntimamente vinculados que no pueden ni deben entrar en contradicción; pero la segunda no se deriva sin más de la primera, sino que posee elementos específicos que deben tenerse en cuenta. En otros términos, junto a las aportaciones que se refieren a los procesos de aprendizaje y desarrollo de los alumnos, el análisis psicológico puede y debe contribuir a la elaboración de propuestas curriculares mediante informaciones relativas a los mecanismos específicos a través de los cuales se ejerce la acción educativa.

Al hilo de estas consideraciones, mi intervención tiene como objetivo poner de relieve algunos de estos mecanismos susceptibles de configurar una concepción constructivista de la intervención pedagógica que, en lógica complementariedad con una concepción constructivista del aprendizaje escolar, proporcione un marco psicopedagógico de referencia útil y coherente para la elaboración y desarrollo de propuestas
curriculares. Comenzaré con unos comentarios generales sobre la concepción constructivista del aprendizaje escolar y de la intervención pedagógica a la luz de las investigaciones empíricas y elaboraciones teóricas recientes que ponen de relieve la importancia de los factores de relación interpersonal en la construcción del conocimiento. Esta discusión nos conducirá el concepto de ajuste de la ayuda pedagógica, que desarrollaré en un segundo momento. En la tercera y última parte de mi intervención, tras mencionar unos cuantos principios generales -fruto de las reflexiones precedentes- que deben quedar reflejados a mi juicio en las propuestas curriculares, concluiré señalando algunos aspectos de la intervención pedagógica cuyo análisis me parece decisivo para alcanzar una mejor comprensión de los mecanismos mediante los cuales consigue ajustarse al proceso de construcción del conocimiento del alumno.

**LA CONCEPCIÓN CONSTRUCTIVISTA**

La concepción constructivista del aprendizaje escolar sitúa la actividad mental constructiva del alumno en la base de los procesos de desarrollo personal que trata de promover la educación escolar. Mediante la realización de aprendizajes significativos, el alumno construye, modifica, diversifica y coordina sus esquemas, estableciendo de este modo redes de significados que enriquecen su conocimiento del mundo físico y social y potencian su crecimiento personal. Aprendizaje significativo, memorización comprensiva y funcionalidad de lo aprendido son tres aspectos esenciales de esta manera de entender el aprendizaje en general,
y el aprendizaje escolar en particular (cf. Coll, 1986 a y 1986 b, para una exposición más detallada).

En una primera aproximación, la concepción constructivista de la intervención pedagógica postula que la acción educativa debe tratar de incidir sobre la actividad mental constructiva del alumno creando las condiciones favorables para que los esquemas de conocimiento -y, consecuentemente, los significados asociados a los mismos- que inevitablemente construye el alumno en el transcurso de sus experiencias sean lo más correctos y ricos posible y se orienten en la dirección marcada por las intenciones que presiden y guían la educación escolar. En una perspectiva constructivista, la finalidad última de la intervención pedagógica es contribuir a que el alumno desarrolle la capacidad de realizar aprendizajes significativos por sí mismo en una amplia gama de situaciones y circunstancias, que el alumno "aprenda a aprender".

Ahora bien, ¿cuáles son las condiciones favorables para conseguir que los esquemas de conocimiento del alumno evolucionen en un sentido determinado?, ¿qué características deben tener las situaciones de enseñanza/aprendizaje para favorecer la significatividad, la funcionalidad y la memorización comprensiva de lo aprendido?, ¿mediante qué tipo de actividades puede contribuir la educación escolar a desarrollar en el alumno la capacidad de aprender significativamente por sí solo en una amplia gama de situaciones y circunstancias? ... En suma, ¿cuáles son los criterios que deben guiar la intervención pedagógica?

Cualquier intento de responder con un mínimo de precisión estas preguntas
pone de relieve la ambigüedad que preside el papel que debe jugar el profesor en las propuestas pedagógicas que sitúan en la actividad autoestructurante del alumno el punto de partida de la construcción del conocimiento y, por lo tanto, del aprendizaje significativo. Esta ambigüedad tiene sin duda su origen en la contradicción que parece existir entre, por una parte, considerar al alumno como el verdadero artífice y único responsable del proceso de aprendizaje y, por otra, atribuir al profesor una importancia decisiva como orientador, guía y facilitador de dicho aprendizaje mediante la puesta a punto de actividades instruccionales. Dejando al margen las razones de orden teórico que pueden explicar esta aparente contradicción (cf. Coll, 1985), quizás una buena manera de superarla consiste en diferenciar dos tipos de cuestiones que, aunque sean de hecho indissociables, conviene no confundir si se desea obtener una comprensión global integrada y no reduccionista del proceso de enseñanza/aprendizaje.

La primera se refiere a los mecanismos psicológicos subyacentes al proceso de construcción, modificación, diversificación, coordinación y enriquecimiento progresivo de los esquemas de conocimiento de los alumnos que facilita o promueve la intervención pedagógica. Aunque estemos todavía lejos de tener una comprensión cabal de dichos mecanismos e ignoremos probablemente la existencia de muchos de ellos, lo cierto es que la investigación psicoeducativa ha realizado importantes progresos al respecto durante las últimas décadas. Así, por citar sólo algunos ejemplos, conocemos la importancia del conflicto y de la resolución del conflicto como uno de los factores que intervienen a menudo en la modificación de dichos esquemas; también, la importancia de la
confrontación de puntos de vista divergentes, ya sea entre los esquemas iniciales del alumno y la nueva situación de aprendizaje, ya sea entre esquemas presentados alternativamente, ya sea entre los esquemas de diferentes alumnos a propósito de la misma situación o tarea; o aún, la importancia de los errores y, en general, de la constatación de los resultados de la actividad propia como punto de partida para tomar conciencia de la necesidad de modificar los esquemas.

No obstante, y sin que ello suponga negar un ápice de interés a estos resultados de la investigación psicológica y psicopedagógica, no debemos olvidar que la idea esencial del planteamiento constructivista consiste en ajustar la ayuda educativa al proceso de construcción del conocimiento de los alumnos. Así pues, la segunda cuestión que conviene plantearse, y a la que es necesario encontrar respuesta para fijar los criterios que deben presidir la intervención pedagógica, es la que se refiere a los mecanismos mediante los cuales se consigue ajustar esta intervención a la actividad mental constructiva del alumno. Es obvio que se trata de una cuestión previa a la anterior: para que la ayuda pedagógica ofertada llegue a incidir –poniendo en marcha los mecanismos mencionados u otros que posiblemente ignoremos aún– sobre el proceso de construcción de conocimiento del alumno, dicha ayuda debe estar ajustada o sincronizada de alguna manera con el proceso que sigue el alumno. Además, es evidente que estos mecanismos se sitúan esencialmente en el ámbito de lo interpersonal y remiten, en primer término, aunque no de forma exclusiva, a la interacción profesor-alumno.
INTERACCIÓN PROFESOR-ALUMNO Y AJUSTE DE LA AYUDA PEDAGÓGICA

¿Cómo se consigue este ajuste? Sólo muy recientemente se ha tomado conciencia de este aspecto del problema y nuestra comprensión de dichos mecanismos es, a decir verdad, terriblemente limitada. La mayoría de las informaciones disponibles en este momento provienen, en realidad, del análisis de la interacción madre-hijo o adulto-niño en situaciones educativas o instruccionales más o menos estructuradas: así, por ejemplo, los trabajos de Bruner (1963) sobre la participación del niño en rutinas o formatos interactivos con el adulto que le permiten adquirir las habilidades comunicativas que están en el origen del desarrollo del lenguaje; los de Wertsch y Hickman (Wertsch, 1979; Hickman y Wertsch, 1978; Hickman, 1978) sobre la manera como las madres enseñan a sus hijos de edades comprendidas entre los 2.6 y los 4.6 años a resolver un puzzle; los de David J. Wood y sus colaboradores (Wood, Bruner y Ross, 1976; Wood, Wood y Middleton, 1978; Wood, 1980) en un conjunto de situaciones muy similares a la anterior; los trabajos más recientes de Saxe, Geahart y Guberman (1984) sobre la adquisición temprana del número; el de Valsiner (1984) sobre la socialización de las comidas; el de Barbara Rogoff (1984) sobre la generalización y transferencia de habilidades; el de Patricia M. Greenfield (1984) sobre la transición entre la comunicación no verbal y la comunicación verbal; o aún, para terminar con esta relación en absoluto no exhaustiva, el de Wertsch, Minick y Arns (1984) sobre la creación de un contexto adecuado para la resolución conjunta de problemas.

El panorama de conjunto que surge de estas investigaciones puede
describirse, siguiendo a Kaye (1982), mediante la metáfora del aprendiz que aprende un oficio en el taller de un maestro artesano. El bebé aprendería el "oficio" de persona, accediendo de este modo al mundo de los símbolos, del lenguaje y de la cultura, mediante su participación en una serie de situaciones interactivas con el adulto en las que el segundo ofrece continuamente al primero oportunidades, ayuda y un contexto significativo para ejercitar habilidades y subhabilidades que todavía no domina, al mismo tiempo que le presenta tareas y situaciones cada vez más complejas a medida que va consolidando las habilidades y subhabilidades ejercitadas.

Más allá de este panorama de conjunto, las investigaciones mencionadas han permitido también identificar algunos mecanismos responsables del valor educativo de estas situaciones interactivas. Entre ellos destaca, por sus implicaciones para el tema del currículum escolar y la intervención pedagógica, el popularizado por J. S. Bruner y sus colaboradores con la denominación genérica de "scaffolding". Como es sabido, la evidencia empírica muestra que los adultos que desempeñan con mayor eficacia la función de "andamiar" y "sostener" los progresos de los niños son aquellos cuyas intervenciones en el transcurso de la interacción son contingentes a los progresos y dificultades que experimentan los niños en la realización de la tarea. En palabras de Wood,

"adult tutorial interventions should be inversely related to the child's level of task competence —so, for example, the more difficulty the child had in achieving a goal, the more directive the interventions of the mother should be." (Wood, 1980, p. 284)

Sin embargo, no basta con constatar la mera existencia del fenómeno. Una
propuesta curricular que se limite a prescribir el respeto a la "regla de la contingencia" tendrá probablemente una utilidad restringida para el profesor, que no puede darse por satisfecho con observar a posteriori el grado de contingencia de sus intervenciones, sino que está obligado en su actividad práctica cotidiana a planificarlas a priori de tal manera que alcancen el mayor grado posible de contingencia. Así pues, para seguir avanzando en la delimitación de los criterios que deben guiar la intervención pedagógica en una perspectiva constructivista, debemos dar un paso más e interrogarnos acerca de las características de las situaciones interactivas que hacen posible un mayor o menor grado de contingencia en las intervenciones de los participantes.

Alcanzamos en este punto uno de los límites de nuestro conocimiento sobre los mecanismos a través de los cuales se ejerce la influencia educativa. Aunque buena parte de la investigación actual de los procesos de interacción tiene como meta superar este límite, lo cierto es que por el momento disponemos únicamente de algunas hipótesis más o menos sugerentes al respecto, pero que carecen todavía de un apoyo empírico sólido. Entre ellas, merece destacarse, por su enorme interés potencial y por su gran valor heurístico, la formulada recientemente por Wertsch (1984) en el marco de un intento de elaborar y profundizar el concepto vygotskiano de Zona de Desarrollo Próximo. El núcleo del planteamiento de este autor se articula en torno a las nociones de definición de la situación, intersubjetividad, negociación de la definición de la situación y mediación semiótica. Un brevíssimo comentario al respecto será suficiente para mostrar hasta qué punto estas nociones son susceptibles de contribuir a mejorar nuestra comprensión de las características de las situaciones
interactivas que hacen posible un mayor o menor grado de contingencia de las intervenciones de los participantes y, por extensión, de los mecanismos que subyacen al ajuste de la intervención pedagógica.

El adulto y el niño que se implican conjuntamente en la ejecución de una tarea o en el desarrollo de una actividad tienen, cada uno por su parte, una definición de la situación, es decir, se representan de una determinada manera la situación y las acciones a ejecutar en la misma. Esta definición intrasubjetiva de la situación es probablemente diferente para ambos. Para que pueda establecerse la comunicación es necesario un cierto nivel de intersubjetividad: los dos deben compartir, aunque sea parcialmente, la definición de la situación y, además, deben saber que lo comparten. O bien no se dará la comunicación, o bien debe producirse una negociación que desemboque en una nueva definición intersubjetiva de la situación. Adulto y niño participan activamente en la negociación, pero su papel es claramente asimétrico; mientras el cambio que el adulto produce en su definición intrasubjetiva es el fruto de una estrategia para establecer la comunicación y, por lo tanto, es un cambio temporal, el que se produce en la definición intrasubjetiva del niño es permanente, o se espera que lo sea, en la medida en que el adulto trata de “arrastrarlo” hacia su propia definición con fines educativos o instruccionales. Añadamos aún que, según Wertsch, el proceso que permite la negociación entre los dos participantes y el establecimiento de una definición intersubjetiva de la situación depende de que se utilicen “formas apropiadas de mediación semiótica”, lo que pone de relieve la enorme importancia de los usos del lenguaje en la relación educativa.
INTERACCIÓN PROFESOR-ALUMNO. INTERVENCION PEDAGÓGICA Y CURRÍCULUM ESCOLAR.

Los trabajos que he mencionado tienen un interés indudable, tanto desde el punto de vista factual como teórico, para el problema que nos ocupa. Muestran la dirección en que debe orientarse el análisis empírico de los mecanismos de ajuste de la ayuda pedagógica, sugieren nuevos problemas de investigación y proporcionan un aparato conceptual rico y coherente. No obstante, conviene ser prudentes y mantener una cierta reserva ante la tentación de establecer un simple paralelismo entre, por una parte, los mecanismos que explican la manera como se ejerce la influencia educativa del adulto durante los primeros meses o años de la vida y, por otra, los mecanismos que desempeñan la misma función en la relación profesor alumno.

Entre otras razones, porque los trabajos mencionados muestran que el ajuste mutuo entre las acciones o actividades de los participantes se produce la mayor parte de las veces de una forma casi automática, natural y espontánea en el caso de la relación educativa entre el adulto y el bebé, mientras que en el caso de la relación educativa profesor-alumno el ajuste está lejos de aparecer como algo dado. La evaluación e interpretación continua de las dificultades del niño, la contingencia de las intervenciones, la adecuación del nivel de ayuda o de directividad al nivel de competencia infantil, la significatividad del contexto de interacción, el establecimiento de una definición intersubjetiva y negociada de la situación, la utilización de formas apropiadas de mediación semiótica; en suma, todos los factores que aparecen prácticamente como dados en la
relación educativa madre-bebé o adulto-niño en los primeros años de la vida deben construirse laboriosamente en la relación educativa escolar para asegurar el ajuste de la ayuda pedagógica.

A la espera de los resultados que las investigaciones psicoeducativas y psicoinstruccionales de la interacción profesor-alumno han de aportar sin duda en un futuro inmediato sobre este aspecto esencial de la relación educativa en el contexto escolar, conviene ahora que concluyamos con unos comentarios sobre el tipo de intervención pedagógica que, a la luz de las reflexiones precedentes, debe intentar promover una propuesta curricular de orientación constructivista.

La verdadera individualización de la enseñanza consiste en ajustar la cantidad y la calidad de la ayuda pedagógica al proceso de construcción de conocimiento del alumno, o lo que es lo mismo, a las necesidades que experimenta en la realización de las actividades de aprendizaje. Los métodos de enseñanza varían en cantidad y calidad de la ayuda pedagógica que ofrecen a los alumnos. Los métodos de enseñanza no son buenos o malos, adecuados o inadecuados, en términos absolutos, sino en función de que la ayuda pedagógica que ofrezcan esté ajustada a las necesidades de los alumnos. Consecuentemente, las propuestas curriculares no deben prescribir un método de enseñanza determinado. Más bien, lo que deben hacer es proporcionar criterios generales de ajuste de la ayuda pedagógica y ejemplificarlos mediante propuestas concretas de actividades de enseñanza/aprendizaje bajo determinados supuestos.

En resumen, y para finalizar, la ayuda pedagógica puede y debe adoptar
formas muy distintas que es prácticamente imposible, y hasta cierto punto accesorio, inventariar de antemano en el Curriculum Escolar. Lo verdaderamente importante es que el Curriculum transmita y ejemplifique la idea de que la ayuda pedagógica es una ayuda en dos sentidos. En primer lugar, es una ayuda porque el verdadero artífice del proceso de aprendizaje es el alumno, de quien depende en último término la construcción del conocimiento. En segundo lugar, es también una ayuda porque tiene como finalidad sintonizar con el proceso de construcción del conocimiento del alumno e incidir sobre él, orientándolo en la dirección que señalan la intenciones educativas y utilizando para ello todos los medios disponibles sin renunciar de antemano a ninguno de ellos: proporcionar información debidamente organizada y estructurada, ofrecer modelos de acción a imitar, formular indicaciones y sugerencias para abordar tareas nuevas, plantear problemas a resolver, etc. La única limitación al respecto, recordémoslo una vez más, es la impuesta por la exigencia de que el tipo de ayuda pedagógica ofrecida esté ajustada a las necesidades y características de los alumnos.

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Adult-Child Communication in a Testing Situation

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In this paper, we propose to examine the testing situation from a social psychological perspective, considering first the child's perception of this context and then looking at the construction of an intersubjectivity between the testor and the child.

Our interest in focusing on the testing situation as our object of study is a consequence of the implications of the results from a series of different researches which we and our colleagues have undertaken during the last ten years:

1) research on the role of social interaction in cognitive development which has demonstrated that, after a short period of interaction, previously non-conserving children can show evidence of having acquired the notion of conservation (Doise, Mugny & Perret-Clermont 1975, Perret-Clermont 1980)

2) research on the effect of social marking on cognitive development which has shown how social norms structuring a task can facilitate the elaboration of a logical concept (Perret-Clermont & Schubauer-Leoni 1981, Nicolet & Iannaccone in press)

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3) research on the role of context which has pointed to the importance of the task presentation in the resolution of a problem in a testing situation (Grossen & Perret-Clermont 1984, Bell, Grossen & Perret-Clermont 1985)

These researches have served to demonstrate that, under certain conditions, children can rapidly pass from one developmental stage to another, thereby defying the laws of cognitive development. Thus, it seemed to us necessary to go beyond an explanation uniquely in terms of cognitive development in order to focus more closely on the social aspects of the testing situation itself.

We began to ask ourselves just what are the situational and relational processes within this particular setting which play a role in the actualization of a logical notion: How does the child come to elaborate his response? How does he make sense of the testing episode?

These questions demand an interpretation of the testing situation as a social event whereby participants enter the situation with a set of expectations of roles and a preformulated definition of the situation (Grossen & Bell 1984). The interaction itself is regulated by rules and tacit agreements and mutual understanding is attained by the sharing of same reality (Mercer & Edwards 1981). A child in a testing situation not only has to activate the cognitions necessary to solve the problem at hand but also has to rely on or elaborate the social knowledge that is essential to the comprehension of the interaction. Our basic hypothesis is that the child’s perception of the testing situation (his definition of the situation, role expectations, etc.) plays an integral part in the construction of his response. Thus, we were lead to analyze the testing situation from the child’s point of view in order to better understand what elements play a role in the elaboration of the child’s responses (and what social knowledge is required to interpret the adult’s discourse and hence succeed at the task).

We have undertaken a series of studies focusing on children’s perceptions of a testing situation, using primarily the Piagetian conservation of liquids test with subjects aged five to seven years old. We have experimented with a variety of different methodologies (mainly qualitative) aimed at studying the mechanisms used by children
in their apprehension of this situation:

1) Post-experimental interviews: After taking the conservation of liquids test, subjects were interviewed by another unknown adult or by the child’s teacher in group or individual settings with the aim of obtaining from the child a description of the testing interview (including his recall of the adult’s questions and his responses).

2) Role-playing: After taking the conservation of liquids test, subjects had to administer the test to another naive child. Each child was asked to take the place of the adult experimenter and show the other child what they had just done together. The interaction between the child experimenter and his subject was videotaped.

We have also analyzed non-verbal behaviour exhibited by the adult and child during the conservation of liquids test as well as having undertaken discourse analyses of the testing interview.

We will now present several observations drawn from our experiments which we feel could contribute to the understanding of the link between the child’s perception of the testing situation and the construction of his response.

A basic observation which has been corroborated by several of our studies is that the adult and the child do not always share the same perception of the interaction. Given their different level of social and cognitive knowledge and their familiarity with different contexts, it is not surprising that the two partners enter the testing situation with different representations and expectations concerning the nature of the task and the purpose of the interaction.

The conservation of liquids test used in our research consists of three sequences of equalization of juice in identical glasses followed by the pouring of this juice into two different-sized glasses. For the adult, this first pouring of quantities of juice in identical glasses is considered as only a preliminary phase of the experimental episode serving to simply establish the premises of the logical problem. The central point for the tester is the question asked after the pouring of the juice into different glasses.
However, this distinction between the premises and the actual problem is not necessarily perceived by the child who is not acquainted with the experimenter's script. He is therefore obliged to judge the importance of a particular element in the testing interview (a question or action, for example) without knowing what is going to follow and not being able to compare elements. We have observed that many children misinterpret the adult's preliminary instruction to pour the same amount of juice in the identical glasses as being the primary purpose of the exercise, spending a long time trying to pour exactly the same quantity of liquid in the two glasses, as we can see in this example:

The child pours the juice into the two identical glasses:

Adult: Do we have the same amount?
Child: (he carefully compares the two glasses)
   No.
   (he adds a little juice to one glass)
Adult: And now? Do we have the same amount?
Child: (he repeats his attempts to equalize the juice)
Adult: O.K., do you think we have the same amount, huh? Is it alright like that? (spoken with a half-questioning, half-affirmative tone)
Child: Yes.

In this example, the child seems to interpret the adult's question as indicating that there is not an equal quantity of juice in the glasses. This triggers his many attempts to rectify the situation which are only stopped by the adult's intervention aimed at making the child understand that he wants to proceed with the interview.

After the pouring of the juice into the different sized glasses, the adult assumes he is asking the child about the quantity of juice yet his actual question ("If you drink from this glass and I drink from this glass, will we both have the same amount to drink or will someone have more to drink or will someone have less to drink?") refers to both the quantity of juice and the action of drinking. The adult evokes the act of drinking simply to introduce a concrete element in the discussion and not to add a dimension to the elaboration of the
notion of conservation. The child, however, often does not have the
necessary elements to allow him to understand which dimensions must be
ignored or taken into consideration in the resolution of the problem.
Thus, children often base the logic of their response on the action of
drinking (speed, etc.) or the potential quantity of juice to be drunk.
As an example, one child answered the adult’s question:
Bea: someone will have more and someone will have less
adult: How do you know that?
Bea: because if we drink and we don’t stop at the same time then it
will make it lower

In another example, the child answered:

Lucie: someone will have less
adult: Who will have less?
Lucie: me
adult: why?
Lucie: because you drank less
adult: But I haven’t drunk anything yet!

In this last example, the child evidently exceeded the adult’s premise
of pretending to drink by imagining they had indeed drunk the juice,
thereby confusing the adult.

What are some of the possible factors which contribute to the child’s
perception of the testing situation? In our post-experimental
interviews and role-playing experiments we have found a relation
between operatory level and the perception of the interaction. We
examined children’s recall of the experimenter’s question and their
response as an indication of their interpretation of the interaction.
Our initial hypothesis was that recall would vary in function of
operatory level with conserving subjects showing a higher degree of
accuracy in their recall as they could be expected to perceive more
easily the aim of the adult’s manipulations. This hypothesis was
disconfirmed by both non-conserving and conserving subjects exhibiting
a selective recall. Non-conserving and intermedium subjects seem to
have the tendency to focus on the inequality of the juice and
therefore perceived the experimenter’s question as a demand to
identify the person who had the most juice. The adult’s question was
often recalled as “Who has more juice?” or “Which one is taller?” or
"Do you have more or do I have more?". Conserving subjects, on the other hand, had the tendency to cite the key phrase "have the same amount" and omit the rest of the question. For them, the adult was often remembered as simply asking "Do we have the same?".

Children's perception of the purpose of the conservation of liquids test likewise seem to vary in function of their operatory level. Non-conserving subjects often focused on elements of the situation which could be considered secondary to the adult. On the other hand, conserving subjects did seem to understand that the problem did not concern the level of the juice in the glasses but the quantity, thereby focusing on the same dimensions as the adult.

Another factor which can be seen to influence children's perceptions of the testing situation as well as their behaviour is the institutional framework in which the testing interview is situated. One way of making sense of an interaction is to "assimilate" the episode to already constructed knowledge which then acts as an anchor linking the unfamiliar to the familiar (Finn 1981,1985). Thus, faced with an unknown situation (as is the case with most testing or experimental situations), it is likely that children will confer meaning to the episode by refering to the scholastic context with which they are familiar. The influence of the school context on children's attempts to make the testing interview comprehensible was observed in the manner in which children assumed the role of the experimenter in the role-playing experiment. Certain role-players conducted the conservation test as a didactic exercise, as exampled by one child who told her subject (when he didn't give the response she expected): "Now, think about it before you answer. You know Carlos, you must think about it in your head. You're here to learn".

The institutional framework also imposes a certain relational structure on the adult-child interaction which contains a certain number of norms and tacit rules of interaction (Elbers 1986). In a school setting, the teacher has the role of asking questions to which he already knows the answer and to which the child is obliged to respond to demonstrate he has acquired the given knowledge. The teacher is then expected to sanction the child's response and to give the correct answer in return. The influence of the evaluative and didactic purpose underlying adult-child communication in a school
context was seen in the manner in which our subjects replicated the conservation test: 41% of the children playing the role of the experimenter gave a justification to their subject's answer. Role-players also had the tendency to explicitly sanction their subjects' answers, as in this example:

role-player: Now, you're going to tell me if there's more or less juice in your glass.
subject: more
role-player: No, that's wrong. Now I'm going to do it again once more and you can correct your mistake.

The prerequisite to the mutual understanding in communication is the sharing of the same implicit assumptions about the reality of the episode. This implies the development of an intersubjectivity which establishes a shared frame of reference with respect to the interpretation of each participant's utterances (Rommetveit 1979,1985). However, adult-child communication in a testing situation differs from prototypic interaction in several important ways. In this context, the social relation between interlocutors is asymmetric as the adult, by virtue of his role, is master of the interaction that he has arranged between himself and his subject. The adult maintains control of the structure of verbal exchange. He has the right to pose questions. This privilege of interrogation gives him the power to define the object of discourse. The adult is familiar with the task presented to the child, he knows the possible means of arriving at a correct response and holds the criteria of judgement of correct answers.

On the other hand, the child finds himself in an inhabitional situation. His inferior relational status implies that one of the conditions of successful participation in the interaction is the acceptance of the premises of interpretation held by the adult which necessitates his making sense of what's going on. Although this activity does not necessarily preclude eventual negotiation between the participants, it does imply that, faced with a novel task, the child's primary task is to try to decode the tacit assumptions of the adult concerning the definition of the situation, the expected roles, the object of the discussion and the 'taken-for-granted' aspects of the interaction.
For the conservation of liquids test, this means that the child must only take into consideration the abstract notion of the quantity of liquid and disregard other immediate elements present in the situation.

How does the child come to give an acceptable response? As the adult giving the conservation of liquids test does not explicitly indicate any positive or negative feedback to his subject, the child is lead to search for interactional cues on nonlinguistic levels. Thus the child is likely to be particularly attentive to the adult’s non-verbal behaviour in this context as it could provide clues to the comprehension of the experimenter’s discourse. Our colleague, A. Brossard, examined adult-child gaze patterns in the conservation test and found that subjects who were non-conserving on a pretest and who gave conserving answers on a posttest after a brief session of peer interaction showed a higher percentage of gazes directed at the adult during the pretest. This could be seen as indicating the importance of children’s interpretation of the adult’s non-verbal behaviour. It is as if these children were looking at the adult in search of an approbation of their insecure responses (Perret-Clermont & Brossard 1986).

This observation indicates that the adult is, in a certain sense, the co-author of the child’s response. That is, a response given in this interactional setting is often a product of the social interaction and can be seen as reflecting a process of mutual construction by the two partners. Thus, in the context of the testing interview, one could expect the child to interpret the adult’s behaviour as signals serving to guide him toward the elaboration of the expected answer (i.e., a potentially codable response which falls within the adult’s logical premises).

We found in the role-playing experiment that our child-experimenters were quite adept at leading their subjects to respond in the way they expected: all non-conserving child-experimenters managed to obtain a non-conserving response from their subject (independent of subjects’ actual operatory level). This observation indicates that not only were child-experimenters skilled at directing the interaction, but their subjects were equally adept at perceiving their interlocutor’s expectations.
What techniques did the child-experimenters use to bring their subjects to give the expected answer? We have identified three principal verbal techniques:

1) If your subject doesn't give an acceptable answer, repeat the question

The idea here is that if you repeat the question, your subject will perceive this as a disapprobation of his response. As an example:

role-player: Is there the same amount to drink?
subject: yes
role-player: Is there the same amount to drink?
subject: no
role-player: that's right

We have found several examples of adult-experimenters also using this technique, with the simple repetition of the question (for whatever reason) triggering a change in the subject's response. An example:

The experimenter asks the key question after pouring the juice into different sized glasses. The child responds:
Child: We both have more to drink because we haven't finished it yet, we have not yet drunk it
The adult repeats his question and the child tries another answer:
Child: No, because we will drink it all.
The adult repeats his question, still not having attained a codable response. The child switches logical premises and replies:
Child: No, because this is short and this is long.
The adult, satisfied at last with this answer, goes on to the next item in the script.

A second technique often used by child-experimenters:

2) Repeat your subject's answer as a form of question
If you repeat the subject's answer in a testing interview embedded in a school context, chances are that he will perceive this as a cue to change his answer. An example:

role-player: do you think we have the same amount of juice?
subject: no
role-player: no?
subject: yes

Needless to say, we have also found examples of an adult's repetition of the child's response eliciting a modification of that response.

And a third technique was observed:

3) Ask the question in such a way so that it tacitly includes the premise of the response

The formulation of the question serves as a guideline for the subject's response. For example, non-conserving role-players asked questions such as "Do you have more than me?" or "Who has the biggest, you or me?". Conserving role-players were observed asking questions such as "Now if I drink my juice and you drink yours do you think we will have the same?". Because the premise is presented as a taken-for-granted background, it was rarely rejected by the subject.

An example of this phenomenon observed in adult-child interaction:

adult: Do we have the same amount or does someone have more or does someone have less?
child: someone has less

This observation points out the contractual nature of questions: answering a question implies that the interlocutor is "contractually bound" (Hundiede 1981) to reply in congruence with its premise. It is possible, in principle, to reject the question. However, in a testing interaction, this would mean the transgression of communication rules whereby the subject is obliged to answer the questions posed by the testor and not to ask questions in return.
To conclude, the child's elaboration of a logical notion cannot be exclusively attributed to his logical capacities. One could say that the child's cognitive performance in a testing situation is a product of the social interaction between the two interlocutors. Mutual understanding and communication between the child and the adult in this situation is attained through the social construction of a shared reality.
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DIDACTIC INTERACTIONS IN MATHEMATICS

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In this paper, I will consider didactic interactions as a particular case of social interaction. I would characterize an interaction as being didactic in nature when an individual has the intention (either explicitly or implicitly) to teach another individual: this would be the case for all organized school systems which place in interaction individuals who have the function of teaching (teachers) and individuals who are obliged to learn (pupils). But it is also possible to consider a relation as being didactic when an individual decodes a didactic intention on the part of his interlocutor. This could be the case for certain psychological tests during which a child could perceive the adult's questioning as being didactic rather than diagnostic. I will not speak here on this second type of interaction (although they are particularly important: see Bell, Grossen & Perret-Clermont 1985, Schubauer-Leoni 1986a & 1986b, Grossen 1988, Bell & Grossen 1986 on this subject) in order to develop the tripolar didactic relation between the teacher, the pupil and knowledge (focusing on the teaching of mathematics).

Elsewhere I have shown (Schubauer-Leoni 1986c) that the teaching-learning situation can only be studied by the joint consideration of the three poles in the didactic relation as each has meaning in relation to the other two. A didactic interaction, like any interaction, is directed by an implicit contract. I would like to consider the existence of the didactic contract which regulates the different aspects of the didactic relation.

I think it necessary to call particular attention to the negotiations undertaken in specific didactic interactions (within the "institutional acts" (as used by Bourdieu 1982) which characterize scholastic practices and rituals) as they are important evidence of the construction of meanings of the object of learning (mathematics in this case) and the maintenance of the interpersonal relationship between teacher and pupil. By referring to my current research on the teaching of mathematics, I would like to demonstrate the pertinence and fecundity of an analysis of didactic interactions in terms of the concept of "didactic contract".

The Didactic Contract: an implicit and tacitly admitted contract

In the didactics of mathematics, the term "didactic contract"

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designates "specific habits" of the teacher expected by the pupil and pupil behaviours expected by the teacher" (Brousseau 1979, p. 181). Thus, one could say that the didactic contract is essentially a system of reciprocal expectations. However, the notion itself of "contract" originates in the concept of "social contract" postulated by Rousseau and has reappeared recently in certain analyses of conversation "in context" (see, for example, Rommetveit 1974, Bachmann et al. 1981, Charauudeau 1982, Ghiglione 1984, Roulet 1985) which stress the negotiation aspect of interpersonal interaction.

According to these analyses, the implicit dimension of the different contracts linking the partners of a relationship is fundamental. Rommetveit (1974) states that the construction of an intersubjectivity "must be considered as taken for granted in order to be attained": the temporary control of the hic et nunc of the dialogue between partners rests on tacitly accepted rules.

The fundamentally asymmetric position is habitually accepted by the two poles of the teaching relationship which is organized in an ongoing interpersonal and scholastic setting. This, coupled with the scholastic knowledge at play in this relationship, enables the didactic contract to regulate communication norms with their specific functions.

One of the characteristics of the didactic contract is the gestion of meaning in relation to knowledge. However, given the fact that, by definition, instruction must produce modifications in pupils' knowledge (that is, progress in scholastic learning), the didactic contract becomes the key organizing factor of those modifications which involve changes in the mutual expectations of the scholastic partners. The teacher's simultaneous gestion of knowledge and interpersonal relations with his pupils is, for the most part, unconscious on his part.

The existence of the didactic contract has been identified in several studies (see Brousseau 1981, Chevallard 1988) which have observed ruptures of the contract by either the teachers or pupils. It is during these incidents of violation of contract that certain rules are made explicit and the nature of contract becomes evident. However, if these moments constitute marks of existence of a contract, it seems to me that they do not permit a full understanding of its habitual (and tacit) functioning. To study what is implicitly assumed in the contractual gestion of this tripolar relation necessitates research techniques which permit the observation of the mutual expectations of the scholastic partners without disturbing their normal functioning.

However, in the light of numerous studies in the sociology and the social psychology of education, it seems to me that a study of the mutual expectations of teachers and pupils is difficult without taking into consideration the category memberships of the actors in interaction. Thus, one should begin by considering the two functions at work in any teaching relation: the function represented by the teacher who has the role of teaching a given body of knowledge and the function
represented by the pupil who must learn this knowledge. These two groups correspond to the two human poles of the didactic relation: what is their rapport with the knowledge put into play by the teacher? How are children from different social groups going to play the expected role of pupils? Does the teacher have different expectations for different groups of pupils? Inspired by Bourdieu & De Saint Martin's (1975) article on "categories of teachers' judgements" I have formulated the hypothesis according to which specific categories of understanding by primary teachers operate in the didactic contract. Thus, the didactic contract becomes a differential contract, determining not only the teacher's representations of pupils of different social categories but also affecting the knowledge taught.

The study of the mechanisms of construction and maintenance of teaching-learning relationships have been the object of various experimental studies which can be classified into two categories: the didactic relation as seen by the teacher and that as seen by the pupil.

The teacher's perspective

Evaluations and, in certain cases, a teacher's predictions in regard to his pupils' scholastic performance were collected in six different contexts which could be considered representative of the practice of the teaching of mathematics in elementary school (for example, teaching or testing organized by the teacher, tests prepared by myself, formal evaluation (report cards)). The expectations of the teacher were then compared to the actual responses of his pupils in order to discover for which pupils and for which tasks differences between expectations and actual performances are observed. The teacher was also asked (before testing and evaluation) to give his opinion on the didactical interest and pertinence of the different tasks presented to his pupils.

An analysis of the collected data has shown the following facts:

- The mental categories used by the teacher to classify his group-class are linked directly to the pupils' socio-economic status: evaluations and predictions of excellence are more often attributed to pupils from advantaged social classes than pupils from disadvantaged social classes. The teacher's evaluations and judgments seem to differentiate his pupils more clearly than objective grades. The teacher's predictions of pupil performance for a given task are more confident for pupils of advantaged social classes than for other pupils: certain pupils from advantaged backgrounds are considered "very good" and therefore the teacher seems to accept one proof of competence to consider the knowledge acquired. On the other hand, other pupils are classified as "having difficulties" (these pupils are most often from disadvantaged backgrounds) and in their case the teacher seems to demand multiple and repeated proof of acquired knowledge before being convinced that they are equally competent.
A scholastic task seems inconceivable in itself and is systematically constructed and described by the teacher in constant reference to the pupils for which it is intended. For example, the teacher, in his a priori analysis of a task, made such comments as "this part is too difficult because it is too abstract" (for his pupils) or "it will interesting to see what the pupils are capable of...". The teacher's a priori analyses of the task have thus shown that, by the very definition of school work, the teacher can only speak of the task in reference to his pupils. The teacher and pupils are already present in this knowledge even before actually interacting.

The intricacy between the teacher's representations of pupils constructed during classroom interactions (representations which take a certain form during the actualization of the predictions of success on a particular mathematical task) and his representations of the task itself (and of its didactic interest appears notably in the teacher's conceptions of possible errors that different pupils could make. The explanations of these errors often fall into two very different categories: in one category, we find discourse referring to oversight, inattention, or forgetting in order to explain errors which could be considered minor; in another category figure explanations that are more deeply engrained in the individual referring to "lack of solidity of acquired knowledge", "behind in all subjects" or "difficulties" of a general nature. These two types of judgements which appear in the teacher's discourse are not aleatory. On the contrary, the teacher attributes the first type of error to pupils of advantaged social backgrounds and the second type of error to pupils of less advantaged backgrounds and who are considered as being less "good" pupils. The comparison of the teacher's predictions with actual pupil responses to the different tasks studied tends to show that, in certain cases, the teacher has the tendency to over-estimate (evaluate) the competences of pupils he considers to be excellent (and of advantaged social classes) and to under-estimate the possibilities of certain pupils of lower and middle classes.

The existence of an implicit didactic contract which varies according to pupils and the nature of the task is empirically verified by the analysis of the types of responses given by the pupils to different activities. In effect, the a priori analysis of different tasks has permitted the identification of the different types of responses expected by the teacher as well as an hierarchy of excellence. An analysis of the pupils' responses has permitted me to identify which pupils have managed to identify their teacher's specific expectations of them. Pupils from advantaged backgrounds seem particularly "good" and "conforming" to expectations concerning a task that is within the didactic contract operating in the classroom. However, when the task is outside the contract established with the teacher (as was the case for the task which I proposed), pupils of lower and middle classes respond better than expected, demonstrating previously unsuspected competences (by the
teacher, at least!)

- The existence of the teacher's differential expectations of pupils of different social categories is also verified by an analysis of the written comments in pupils' report cards. (Socio-economic and sexual categories have been identified, but these two groups do not exhaust the "categories of understanding" used by teachers).

These observations serve to show that despite the varieties of individual logic of teachers as well as the style and rhetoric of scholastic evaluation, the 92 pupils of the five classes studied are classified by teachers into categories of excellence which are related to categories of social origin. However, it seems that the social composition of the group-class also has a certain importance: the positioning of excellence is not the same for a middle class pupil if he finds himself in a group-class with a relatively strong proportion of advantaged pupils or if he is only compared by the teacher to pupils of the same or inferior social class.

The pupil's perspective

Up to here, pupils have appeared as the teacher's interlocutors or as "receivers" or "interpreters" of the explicit and implicit message of the teacher. However, the didactic contract as it appears from the teacher's position puts into play a system of non-interchangeable positions where the highest place is inevitably occupied by the teacher who is master of the teacher-pupil relation. The subtlety of the gestion of the relation with the knowledge relies on the negotiation of distances between the social and didactic positions of the partners.

How do pupils perceive this tripolar relation? By placing pupils in a situation where they had to play particular roles, I managed to have access to their conceptions of mathematics as it is taught and to the way this knowledge is organized in a teaching relationship.

The pupils studied were asked to play the role of "a little teacher" by first constructing mathematical tasks for other pupils of the same age or younger and then submitting these tasks to the intended pupils.

Concerning the 63 tasks formulated by the pupils, I would say first of all that they appear to be dependant on the social conditions in which they were produced. In effect, the "little teachers" of 6th graders and 2nd graders all constructed tasks whose content and form resembled exercises in use at school. However, the pupils' daily role had trained them as "answer-givers" and not "gestion inventors". As a result, their questions were often constructed from the response to a problem found in a math book. Thus, certain tasks invented by pupils were already resolved or were irresolvable.

For example, 7-8 year old pupils have a particular fondness for certain exercises in their math textbook which consist of connecting numbered dots so that a figure appears. The interest for this type of task resides in
the discovery of the "hidden" drawing and pupils do not question the mathematical meaning of the exercise. Trying to reproduce a task of this type, seven year old "little teachers" invented the following "exercise":

With the aim of letting their "pupil" discover the name of "Marc", the "little teachers'" exercise becomes an amalgam between the question (linking the numbers in increasing order) and the response (making the name "Marc" appear) by inadvertently making the name appear by placing the numbers too close. Thus, question and response are superimposed.

If we examine the interactions between the "little teachers" and their "pupils", we find a perception of the didactic relation in which figures a strong dissymmetry between teacher and pupil. Not only do we find a relation with high and low positions, but the role of knowledge plays a fundamental role in the creation and maintenance of this relational dysymmetry.

My data collected from pupils as well as teachers leads one to believe that it is because the teacher knows something that the pupils do not that enables him to function as a teacher.

Since the teaching relation is modulated by teachers' and pupils' social experience which helps create the different degree of the objective and subjective distances between the two partners, knowledge constitutes a central factor in their respective positioning.

Systematically, each time a pupil temporarily took on the role of "teacher", he had much difficulty as a questioner and regularly slipped back into the pupils' role by marking his behaviour with signs usually associated with that role and attributing to the adult observer the role of the holder of "real knowledge". This type of slippage is often present when the "little teachers" are of the same school grade as their "pupils" who have the same level of scholastic competence. In this situation, interpersonal perceptions become particularly important to the regulation of this relation which is objectively quasi-legitimate (does the "little teacher" really know enough to question one of his peers?): who believes himself to be a "poor" or "good" pupil and is perceived as such?

All questioned children were asked to construct the following situation: prepare a "hard exercise" for poor pupils. The notion of task difficulty ("hard exercise") and academic standing ("poor pupils") are two conditions which reconstitute the tripartity of the didactic relation and the interplay of social distances as perceived by pupils.
The analyses of the interactions confirm the existence of a gestalt of knowledge by the "little teacher" who tend to avoid a destabilization from their high position by their "pupil". To simplify, I would say that when the "little teachers" are 11-12 year old pupils faced with 7-8 year old "pupils", their strategy consists primarily of marking their superiority by demonstrations of their scholastic competence during which the young "teacher" completely organizes the response in the place of his "pupil" who consequently has only limited access to the question and the knowledge concerned. This strategy of gestation of knowledge within this particular didactic relation has the immediate effect of making the "little teacher's" questioning legitimate in the eyes of the pupils. On the other hand, when the teaching relation consists of children of the same school grade, the regulation of interpersonal distances during the interaction is most often achieved on a purely relational level despite the precautions taken by the "little teacher" to maintain his position of authority ("hard problem for poor pupils"): the "little teacher" constantly oscillates between an attitude of censure (one who "knows" and corrects), an attitude which often appears haughty with snickers in reaction to the "pupil's" errors, and attitudes which consist of responding in place of the questioned "pupil".

Between peers, holding a "high" position in relation to the other pupil and to the knowledge concerned is not very easy and it is not rare that the positioning between the two partners suddenly shifts in favour of the "pupils". The following is an example of this observed phenomenon:

The "little teacher" begins to correct, pencil in hand, the pages of calculations that she gave to her "pupil":

"pupils": oh! (exclamation which follows each response declared correct by her "teacher")
"teacher": I really helped you, huh?
"pupil": Come on, quicker, quicker!
"teacher": Do you mind! I don't know... and besides you already have two mistakes.
"pupil": go on... it's easy-peasy

By admitting her ignorance, the "little teacher" destabilizes an already precarious "high" position, the relation becomes explicitly symetric, and the children find themselves on the same side opposed to the adult and the question.

**Conclusion**

The data collected from teachers and pupils tend to show that the didactic relation is a tripolar relation and not a bipolar relation as suggested by the scientific tradition in psychology of education or by certain sociological analyses. Furthermore, if the pole of knowledge is a key element in the positioning of the other two poles, it would also follow that knowledge constantly changes its nature in the adjustment of the complementarity of the teacher and pupil roles. Whether the interaction is directed by a teacher employed by the scholastic institution or by a temporary "little teacher" legitimated only by the punctual contract in the context of the research, an important part of each partner's energy is devoted to the relation and
its control as each is particularly desirous of avoiding losing face. It is in this complex interpersonal interaction that mathematical skills are constructed, formulated and sometimes validated and institutionalized.
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LITERACY DEVELOPMENT THROUGH SOCIAL INTERACTION

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Considerable attention has been focussed in recent years on the social and cognitive interaction that can develop among children (Forman, Cazden, 1985). Particular emphasis has been laid on the educational potential and effectiveness, as far as learning and knowledge building are concerned, of exchanges among children, whether of the co-construction or disagreement types (Damon, 1984; Pontecorvo, 1985). Nevertheless, this is still more a working hypothesis than the result of research carried on under real school conditions. Little work has been done on the factors of task and context (Garvey, 1986) characterizing the interaction and making it possible. We believe that such interactions among children are not always "natural" nor are they necessarily constructive when the children are free to interact in the presence or absence of the teacher. There is a need to develop skills both in the teacher organizing and managing the interaction and in the children taking part in it. The present paper describes an attempt to develop and subsequently modify in a qualitatively more productive way the teacher's ability to elicit and sustain the interactions.

1. Research context

The research involved a sample of 40 children of different ages enrolled in two classroom subjected to a longitudinal study from the ages of 4-5 to 7-8, for whom a reading and writing curriculum had been devised (Pontecorvo, Zucchermaglio, 1986). The proposed curriculum was subdivided into the following content areas:

a) use of/reflection on oral language
b) writing construction and interpretation
c) text composition
d) early reading
e) text comprehension

The most significant methodological aspect of the curriculum was the creation of a social context involving:

a) the use of a suitable information environment to arouse and sustain children's curiosity about the written language;

b) the use of peer interaction as a learning source in view of the role played by social interaction in knowledge building.

2. Teacher training

The teachers involved in the experiment had no initial experience of or familiarity with teaching work organized on the basis of small groups of children. The work of training them was therefore organized as follows:

- During the year preceding the beginning of the experiment and during the early part of the first year, the researchers' work consisted of "adult level" activities covering areas and topics related to the written language. Teachers and researchers participated in group discussions concerning the activated processes and the relevance to teaching of the specific contents and of group work methodology.

- During the first year of the experiment the work of developing a teaching methodology
based on interaction among children followed three guidelines:

a) preparation of a timetable to allow teachers to be present at school at the same times;

b) theoretical and methodological action aimed at getting the teachers to appreciate the potential and value of knowledge constructed socially by means of collaboration, disagreement and mutual help, and to develop the teachers' ability to decentralize the management of the interactions;

c) practical situations in which small groups of children (3-4) actually worked on a free writing exercise (Ferreiro, Teberosky, 1979).

- During the second and third years of the experiment the work continued according to a less rigid schedule in the course of the weekly planning. It mostly took the form of reflection on/discussion of the teachers' choices regarding both the organization of teaching time and the way of handling the groups of children in the various settings (always recorded and transcribed).

3. The specific task

The analysis bore on those activities in which the teacher worked for about 30 minutes with a group of 3 children. The group was formed by applying the principle of "graded heterogeneity" in order to ensure the existence of different ways of constructing the written language (Ferreiro, Teberosky, 1979) without foregoing peer communicability and the possibility of comparison.

One of the aims was in fact to use the comparison between different ways of writing to cause conflict leading up to the restatement of the assumptions used by the child in her/his writing.

In addition to the specific objectives of the activity (cfr. Zucchermaglio, Pontecorvo, 1986), the teacher had to bear in mind two methodological considerations (Pontecorvo, 1986) when carrying out her work:
- to arouse and focus the children's attention in order to allow the analysis of the problem to continue
- to deliberately cause a cognitive conflict by comparing children's positions and bringing out differences and similarities inherent in them.

4. Materials and method of analysis

Analysis of the way the teacher handled the interactions was carried out using the transcripts of the writing activities of small groups which had been collected in three years of experimentation carried out by the same "target" teacher. Changes in the interactions collected during the three-year period were described and characterized by making a distinction between task and context of the interaction. The situation we selected can be characterized as follows:

A) Task. The task at which the children worked was the same for the entire three-year period as regards the organizational aspects (number of children and "graded heterogeneity" of the group), the explicit instructions given and the explicit objectives and meta-objectives to be pursued by the teacher.

B) Context. The context factors related to the teacher are as follows:
- organizational skills as evidenced by the capacity to form the groups of children, taking care that they are balanced, and taking interpersonal dynamics into account;
- management skills, defined as the capacity to manage peer and children-teacher interactions adequately, exploiting the cognitive potential offered by social exchanges to the full.

5. Assumption.

It was predicted that the teacher's skills would be modified both by the adult-level training received and her enhanced familiarity with working in small groups.
6. Results

During the first year of the experiment the teachers continued working without using small groups, also when two of them were simultaneously present in the same classroom. Only towards the end of the year, and after the warm "encouragement" of the researchers, did the teachers organize work periods involving three children engaged in a written language task. During the first year the teacher was allowed complete freedom to decide on the composition of the children's groups.

From the point of view of group management the teacher, that we analyzed, introduced and directed the work and played a very marked regulatory role, as is shown by the average number of her interventions (about 50% of the total). The effectiveness of redirecting the problem back to the group of children had still to be acquired. This is clearly indicated by text 1 in which Val. and Em. spell out their names syllable by syllable: by spelling them out this way some letters are "left over" and the problem facing the children is to explain the function and the significance of these letters. Although credit must be given to the teacher for perceiving the problem and of allowing it to emerge, she intervenes and gives the children the key to the correct interpretation (99,101) in the belief that this will ipso facto be adopted by the children as the right way to read. The child's reaction (102) illustrates the inadvisability and uselessness of the teacher's intervention:

Text 1

97 T.: Would you read your name please Val.?
98 Val.: /va/(V)/len/(A)/ti/(L)/na/(E)....
99 T.: Do it this other way.
/v/(V)/a/(A)/l/(L)/e/(E)/n/(N)/t/(T)/i/(l)/n/(N)/a/(A)
100 Val.: /valentina/(VALENTINA)
101 T.: Are you sure? This way it adds up. There are nine symbols: /v/a/l/e/n/t/i/n/a/. Are you sure?
102 Ema: Is the tape recorder on?

The greatest number of changes occurred during the second year. Starting in January it was envisaged that each teacher worked with a subgroup of 10 children, but only in two main working periods. As the various activities were carried out, this made it easier to form further subgroups within the class. Furthermore, the teacher got separate groups of three children to carry out writing tasks in a setting that was different from the normal classroom. These working periods became a regular feature for the rest of the school year.Group management was characterized by the numerous explicit interventions by the teacher to remind the children of the reason they were working together, to emphasize the value of group work and to request/encourage the children to help each other. These interventions seemed to correspond to an explicit urge for the teacher to convince herself of the need for a social mode of knowledge building.Nevertheless, a significant quantum leap was observed in the management mode used: teacher intervention rapidly declined (30%) with the result of producing cognitively constructive peer exchanges. Moreover, the interventions were mainly aimed at sustaining/regulating the interaction and at focussing attention in order to allow the analysis to proceed, erecting a scaffolding' over the salient aspects of the problem (Wood, Bruner, Ross, 1981).

The direct suggestion of solutions was almost totally replaced by mirroring techniques (Lumbelli, 1982) and the referral of the problem, now defined and made explicit, back to the group. This is illustrated in text 2 in which the teacher first mirrors Giu.'s statement (39) and then refers the problem to Ga. (41), who had already helped to solve Giu.'s problem (33) of letters left over when spelling out her name.
Text 2

33 Giu.: /giuuuuu/(G)/ii(i)/o(U)...
No, I can't understand it at all.
34 Gai.: Perhaps there's an /o/?
35 Giu.: What?
36 Gai.: An /o/.
37 T.: There is an /o/.
38 Giu.: But here there's everything Mummy wrote for me.
39 T.: Here's what your mummy wrote.
40 Giu.: I think there's something missing (mutters).
41 T.: You think something is missing... Hey, Ga., Listen darling, he has written his name. Shall we help him? Shall we all try and see if he has spelled his name properly, or would you like to write your own?
42 Ga.: Wait a minute.

It should be stressed that simultaneously with, and probably not independently of, this change of management mode there was a gradual improvement in the understanding and internalization of the aims of the linguistic activity.

During the third year the teachers coordinated their group work even more effectively with their normal school timetable. The children spent almost the whole schooltime working simultaneously in 4 subgroups (about 8-9 children) each with one teacher. These groups then remained the same for several activities, including the construction of the written language. Within these groups it became customary for the teacher to alternate between 2 or 3 working groups, allowing each group in turn to work independently. From the point of view of group management, the teacher used the skills gained the previous year with increasing confidence, demonstrating a clearer understanding of the aims of the interaction, as well as those of the specific task. She no longer needed to explain to the children or to herself the reasons for working in groups. The result was an improvement in quantity and quality of peer interactions.

7. Conclusions

The development of the teachers' skills in devising and sustaining a working method giving priority to social interaction as a source of knowledge building can be summarized as follows: a first year in which the training content could not be adequately implemented independently was followed by a second year marked by considerable changes, which were more rapid at the management level than at the organizational level, where there was probably more resistance; by the third year group work had been accepted as normal practice, group management had been fully mastered and considerable improvements had been made at the organizational level. The length of time required for the proposed methods to be assimilated and implemented shows how difficult it is to change either the way the interaction is managed or, above all, the more resistant modules into which the teachers' work at school is organized. It also reveals the "non natural" nature of children's capacity for interaction.

Notes

1) There were three teacher in each of the two classroom: during the main working periods two teachers in each classroom were simultaneously present at school, in different periods and ways along the three years of the experiment.
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ARGUING VERSUS CO-CONSTRUCTING IN CHILDREN'S VERBAL
INTERACTION

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1. Introduction: comparison between two paradigms

This paper, which uses a previously developed theoretical framework (Pontecorvo, 1985b), is intended as a contribution to the ongoing debate on the role of several different modes of social interaction in the acquisition of knowledge. This debate is characterized by two main positions: that of the researches of Doise, Mugny and Perret-Clermont (Perret-Clermont, 1980; Doise, 1983; Mugny, 1985), who consider the socio-cognitive conflict to be a fundamental tool for transforming and acquiring knowledge, on the one hand, and, on the other, the neo-Vygotskyian approach, in which priority is given to the role of social support played by the adult and the more competent peers, as developed by Wertsch (1985), Cazden and Forman (1985), Bruner (1986) and others. These two theoretical approaches are not, however, antithetical. As pointed out by one of us (Pontecorvo, 1986), they relate to complementary processes of social support which are simultaneously present during knowledge building. Moreover, further research is required in order to get a higher level of specification for different modes of peer interaction, both consensual and conflictual, identifying the different roles that these modes may play.

In previous analyses of classroom discussions (Pontecorvo, 1983; Pontecorvo, Castiglia and Zucchermaglio, 1983), complex processes of "discourse-reasoning" were found to occur both during convergence between the speakers' points of view and during disagreements and quarrels. While during "co-constructing" phases, to use Damon's (1984) term, the children are piecing the various incomplete parts of their ideas together, during the debating phases, their reasoning around the problem proceeds vigorously, by means of disagreement with statements made by others, justification of one's own point of view, counter-arguments, and attempts to find more satisfactory guarantees and backings (Toulmin, 1958).

Therefore, the role of "disputing" and of "co-constructing" in the acquisition of knowledge does not have to be related back to conflicting theoretical paradigms.

Within this problematic framework the aim of the present paper is to identify more accurately different modes involved in peer interaction processes and, using observational methods, also their possible effects on the acquisition of knowledge.

Furthermore, since previous research had been carried out only for children aged 8 to
11 years, the present research was focused on 5-7 year olds, also in order to detect the existence of any developmental differences in the interactive processes occurring in classroom discussions. The results reported herein are part of a wider ranging research project in which discussions on two scientific subjects and two narrative ones were produced and analyzed. In the present paper, only the work on the "equilibrium" topic is discussed.

2. Methodology

Twenty-four subjects were observed - 12 kindergarten children (aged 5-6 years) and 12 second grade children (aged 7-8 years). Each subject took part in two large-group discussions (including all 12 children in the same age group) and two small-group discussions (among 4 children of the same age). The discussions of both kindergarten and second grade children were led by their respective teachers. The teachers had previously carried out "trial" conversations on different topics aimed at developing only for children aged 8 to 11 years, the present research was focused on 5-7 year olds, also in order to detect the existence of any developmental differences in the interactive processes occurring in classroom discussions. Suitable verbal strategies to facilitate inter-child communication as much as possible. The subjects chosen in each age group were judged by the teachers to have good or average linguistic ability and the small groups were composed of children with heterogeneous abilities. The discussions were conducted according to the procedure described in fig. 1, taped and transcribed.

Figure 1

PROCEDURE

Familiarization
with materials----------------------types of scales for a short time

Initial discussion:
request for predictions--------The teacher asks the group of 12 children to predict how each type of scales can be made to balance

Manipulation of scales: experiment
Discussion of experiment in small groups

Each group of 4 subjects takes part in two experimental sessions using the materials followed by a discussion

Final Discussion-------------------Participation of the whole group of 12 children
Two different types of units were used in discussion analysis. The first unit is the exchange, defined as the link between two not necessarily contiguous conversational contributions. A conversational contribution consists of all the utterances contained in a single turn. The link between two contributions is ensured by that of the topic and/or by a pragmatic type of relationship. The second unit of analysis used is the sequence, i.e. when there are at least three, not necessarily contiguous, conversational contributions, linked by continuity of topic and/or in which each contribution is associated with the preceding one by a pragmatic relationship.

The aim of exchange and sequence analysis was to seek a typology of social interaction processes occurring during the discussions. A second aim was to clarify whether the different types of interaction corresponded to different stages of conceptualization of the problem discussed. It had already been postulated (Pontecorvo, 1985) that co-construction processes (in which one dimension of inter-speaker consensus prevails) occur at a stage of “warming up” and of preliminary identification of a common universe of discourse, while processes of disagreement and conflict leading to dispute occur when a problem has already been clearly identified.

One further aim was, albeit using a purely explorative methodology, to ascertain whether verbal sequences, different at the level of socio-cognitive interaction, correspond to different knowledge acquisition processes.

3. Exchange typology

A distinction has been made between consensual exchanges and conflictual exchanges (involving a clash between different ideas). As Tab. 1 shows, it was found that in the conversations of both nursery school and elementary school children exchanges in which disagreement is expressed are definitely the most frequent.

<table>
<thead>
<tr>
<th>Table 1</th>
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<tbody>
<tr>
<td>Number of exchanges for each main type and school grade</td>
</tr>
<tr>
<td>Exchanges</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>Consensual</td>
</tr>
<tr>
<td>Conflictual</td>
</tr>
</tbody>
</table>

Our analysis has led to the identification of the following exchange types:

EXCHANGES INVOLVING CONSENSUS
1 "I agree"
   Simple expressions of agreement with a previous statement.

2 "I am defending our shared point of view"
   To repeat, adding explanations or clarifications, the statement of a speaker to whom objections have been made.

3 "Let us build together"
   a - restating and adding to a previous utterance considered unclear or incomplete.
   b - variation in the content of a previous utterance in which an hypothesis is expressed
   c - chaining an explanation

EXCHANGES INVOLVING CONFLICT

4 "There are other aspects to consider"

5 "Let's see if what you say is really true"
   Requests for explanations and clarification.

6 "Things aren't how you say they are"
   a - Denials or clarification concerning single "data": objects, attributes, actions.
   b - Conflicting evaluations of adopted procedures
   c - Conflicting evaluations of hypothesized procedures
   d - Disagreement with a previous statement, with reference to "laws", analogies, causal processes.

   Only two examples have been given for the broad categories of consensual exchange and conflictual exchange. In the first of these an explanation (3c) is given using various type "3c" co-constructive exchanges.

   (This is the final conversation; the teacher has just pointed out that the see-saw is not always in a state of balance even when cylinders are added as weights.)

195 Pie. "Miss! We put the cylinders on too, but we couldn't get it to balance either; sometimes it did and sometimes it didn't"
196 Wal. "Because, because it is difficult to get it to balance!"
197 Sab. "It wouldn't balance because we got nervous, because we were too excited, that's why we couldn't, because we were putting them (the weights) on in a hurry."
198 Wal. "They were new for us" (we got excited because they were new games).

The next example involves an activity of variation to and adaptation of the contribution made by another child (3b)
(The teacher has asked whether it is possible to balance a wooden surface, the "lake", on top of a ball placed on a glass)

268 Sab. "Take out the ball, turn it (the glass) upside down and put it (the "lake") on top, and it will hold it..." (the lake will balance)

   (The teacher makes it clear that the glass cannot be turned upside down and that the ball cannot be removed)
286 Al.O "Or else, do this, leave the ball inside. Why not take two glasses? Leave the ball inside, then put the other glass here and the first one will stand up straight".

(From the gestures used the intention is clearly to put another glass on top of the first one containing the ball).

Al.O is thus adapting Sab.'s idea of sidestepping the problem caused by the ball and seizes upon the idea of turning the glass upside down so as to be able to balance the "lake" on the bottom of the glass.

In conflictual exchanges the disagreements based on fact (type 6) occur in the form of:

a) pointing out facts (denials or clarification concerning events or actions referred to in a previous contribution);

b) evaluation of the results of procedures; this type of disagreement can be summed up in the statement "You said that by doing "A" you get "B", I did "A" but I got the opposite of "B" (or, I did the opposite of "A" and I got "B"). The latter type of objection is very common and seems to be one of the main tools used in comparing experiences during discussion.

(Sim. and Ple. have managed to get the two arms of the scales to balance; Al. and Fe.P. are very upset at not having achieved the same result; Fe.P. asks Sim. for explanations).

16 Sim. "because we attached.... first we ... the scales ... we...
17 Al. "... held it"
18 Sim. "held it here like this" (we first supported the two arms of the balance with our hands).
19 Al. "Didn't we hold it? What did we do?" (we supported the arm too, and yet...)
20 Sim. "Afterwards we put it on, we put the light things on, though (we added the light weights). Afterwards we left it #and it balanced. That's why it still balances.
21 Fe.P "Of course."
22 Al. "We put the light things on too but it wouldn't balance".

4. Knowledge building and expression

In analysing both consensual and conflictual sequences it has been attempted to distinguish between the qualitatively more complex sequences characterized by "high level thinking" (Bruner, 1980) and simple sequences. Although only a rough distinction, it was thought that it could provide a starting point for an investigation of the effects of interaction processes between children.

Simple sequences were defined as being characterized by:
- irrelevant objections and/or replies;
- (unvaried) repetition of previously stated hypotheses;
- plain denials or expressions of agreement;
- absence of any kind of justification

Complex sequences display one or more of the following characteristics:
- identification of new problems, untouched in other discussions and not elicited by the
teacher's questions;
- attempted explanations in terms of causal processes;
- identification of new variables referring to the phenomenon being discussed;
- search for and statement of generalizations.

Table 2

Number of "simple" or "complex" verbal sequences, by schoolgrade and type of social interaction.

<table>
<thead>
<tr>
<th>School grade</th>
<th>Consensual sequence</th>
<th>Conflictual sequence</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Simple</td>
<td>Complex</td>
</tr>
<tr>
<td>Kindergarten</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Second grade</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

The results set out in Tab. 2 indicate that the conflictual sequences in which there is a clash of points of view are more likely to be of the complex type than sequences in which only a consensual type of interaction occurs. This is equally true of both kindergarten children and second grade children.

It could be postulated that, in conflictual sequences, children are more highly motivated to speak their minds, resulting in a greater linguistic and cognitive complexity of verbal exchanges. In our view, the greater complexity of the conflictual sequences is linked also to the building of new knowledge (that takes place in this type of interaction) which could be the "product" of the conflict. This claim is based on observation of the knowledge on which individual children drew for the purpose of making their conversational contributions at the beginning and end of the experiment.

5. Discussions of results and conclusions

The results set out above show that co-construction dimensions mingle with conflict dimensions in verbal interactions between children. Both these components seem to play an important role in the building of knowledge. In particular, interactions involving consensus are essential to the "circulation" of information among children so that each one can reflect upon and assimilate the other's point of view.

On the other hand, interactions involving disagreement were found to be fundamental to "high level" thinking processes. The seeking of explanations, the identification of new problems, the representation of new aspects of the subject matter, are much more likely to occur in the case of conflicting points of view than when children agree. A very close relationship thus exists
between situations characterized by conflicting points of view and the emergence of processes of conceptual change and acquisition. However, in our research we have been unable to establish the direction in which this relationship proceeds.

Disagreement could conceivably provide a context in which the cognitive capacities of the children, which have already been constructed and acquired, are "challenged" and therefore expressed and utilized to greater effect. On the other hand, the need to convince someone who is raising objections may be a strong factor in the activation of reasoning and evaluation processes leading to knowledge being modified and linked up in different ways.

Both the above hypotheses in any case confirm that disagreement with a stated point of view plays a very important role in knowledge processes by activating various arguing modes (Pontecorvo, 1985).

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THE PLACE AND ROLE OF THE COMPUTER IN SCHOOLS

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After numerous experiences with the installation of various types of equipment in different countries, one cannot affirm, on the basis of results obtained, that the introduction of computers in schools is satisfactory. If one often observes interesting innovations, one also sees the resistances, the attraction to novelty and considerable misuse of equipment 1). In recent years various projects have shown that there were no significant differences between training with or without computers (see for example KULIK AND KULIK, 1980). In fact, recent experience has shown that the use of computers in teaching is relatively limited (see for example, a study on the schools in the city of Fort Worth published in Educational Technology (Seidman, 1986)). Some articles in American specialized literature even refer to "computer literacy" as a myth (Kalmar, 1986).

We do not have at our disposal an overall set of criteria which takes into account the wide range of systems. This is exactly the problem. To establish such a system would mean establishing a theory concerning innovations in the field of new technology for schools. By necessity this would involve an overview of the factors which play a role in the success or failure of these technologies and in their having short or long term effect.

We are of the opinion that attempts to introduce computers in schools have often involved the following characteristics:

- they have lacked historical perspective and taken little account of the resistance to change in school systems. They have particularly failed to take account of similar experiences, previous or contemporary, involving other communication techniques such as video, cinema or other means of access to sources of documentation. One is struck by failure of one group

1) My observations are based on a long experience: I first began working in the field twenty years ago: I have worked with my team from 1967 to 1973 on the creation of a CAE system for the COCHIN Hospital in Paris for training doctors in the diagnosis of illnesses of the blood; I have been responsible during four years for the service which undertook amongst other activities, under C. LAFOND's leadership, the experience referred to concerning the fifty-eight secondary schools; and I have carried out research since 1973 on the use of the LOGO system in elementary school.
to draw lessons from the experiences of another. I spent five years in rediscovering the use of slides and magic lanterns by schoo's at the turn of the nineteenth century, a technique which was very widespread in the U.K. and in France, and which has been totally abandoned since (Perriault, 1976, 1981).

- these attempts were based on the notion of the, (presumed but not proven), overall benefit, of computers for training, and they have placed the major emphasis on the equipment. The question then became: "now that I have a computer in my school, what am I going to do with it?". Thus, the question was approached the wrong way around as the goal was to use the machine and not to develop a teaching tool which necessarily would involve the use of such a machine, even if it were not available in the school. There were a few examples of innovations in France, the history of which has yet to be written.

- these attempts were also based on technical reasoning which involved examining the relationship of teachers or of students to the computer without taking account of side effects due to the context in which the experience took place. Children come from different cultural backgrounds, and have different approaches to learning. Teachers have colleagues, professional ambitions and different motivations. Many of these experiences and projects were based on a functional view of training. This technical viewpoint, that of computer specialists and engineers, led to the establishment of a compendium of knowledge which teachers were supposed to be able to acquire but which was essentially different from that which their own technical background would incline them to acquire.

The point I want to make in the following pages is the following: we have not paid enough attention to the fact that a computer is a piece of equipment, more complex than most available instruments but to be used just in the same manners as one uses a shovel, a pick, a television or a car. The history of technical innovations has shown us:

- that use of equipment is not always logical, and often is regardless of its technological conception,
- that equipment does not enter into a given environment without modifying it somehow.

Equipment does not necessarily remain in the place in which it is initially installed. There are numerous examples of this in the history of communications. The phonograph was supposed, amongst other things, to permit people to record the voice of someone who was going to die. Closer to us, drivers were supposed to be able to communicate with drivers of other cars with Citizen Band, whereas it has been taken over by truck drivers. The French MINITEL was supposed to serve as a source of information, whereas it is primarily used for other purposes. In other words, it is as if each type of equipment had to find its own place in the environment (PERRIAULT, 1986).

The setting therefore becomes very important. The computer was not designed to solve pedagogical problems. It has been taken out of its original context and been reinserted in another, and it is precisely the conditions of this reinsertion which merit study.
Now, in order to ponder more closely at the interaction between the use of the equipment and the context, I will first consider the micro-setting of the class or club and then I will focus on the institution as a whole. I would like to re-examine the question of the use of the computer in schools in the light of these two points of focus.

1. The Computer in the Micro-context of the Classroom

In my opinion the choice of the use which will be made of a computer in a classroom should be viewed in the light of three considerations: a theory which accounts for the observable facts; the positive effects of computer use on certain of the children's cognitive mechanisms; and, thirdly, the effectiveness of the equipment for teachers.

A. A Complex Set of Interacting Factors

When one observes a classroom where teacher and pupils are working with a computer, one is struck by the number of elements in play and of which current theories about learning do not take account. There are various attitudes: certain children are dogmatic, others are experimental. There is often a question of rules: a teacher who teaches LOGO and encourages initiative on the part of the children will not tolerate, beyond a certain point, that the pupils no longer need his or her advice.

There are different rules: some act directly, others explain things to their friends who will then follow them. Some reflect on the content of the problem, whereas others are very clever at finding ways of solving it. Often children talk amongst themselves to try to find solutions, make different proposals and use methods which were never imagined by the program.

There are communication issues, and different points of view. Like the example of this six year old girl who wanted to draw a boat and wrote in LOGO:

FOR BOAT
The machine answered:
YOU DID NOT TELL ME HOW TO DO IT
She then wrote FOR HULL, then FOR MAST, FOR SAIL, etc imagining that the machine knew how a boat was made and that it could list the elements which make a boat. A complete misunderstanding. The LOGO language becomes then a type of hieratic sphynx which has no place in Papert's theory (PAPERT, 1980).

One could give endless examples of this type. Whereas at the outset wide-scale experiences were undertaken, we have now progressively moved towards a more and more refined analysis of the possible uses of computer (R. LAWLER, 1985 or S. TURKLE, 1984) and the methods of observations have then been borrowed to ethnology and ethnomethodology.

The reason for this move is that observers saw that the relationship between children and computers did not function the way adults had imagined
it would - an observation which in itself is enough to awaken scientific curiosity. What is needed is a basic respect for the inherent logic of the user. We are then confronted with some difficult problems. In reality, neither the assimilation nor the exchange of technological functions are simultaneous but they take place in an irregular fashion over an undetermined laps of time.

When a group makes use of a computer, one observes various types of interactions. Some are part of the learning process in the strict sense of gaining access to information stocked in the program. But others are created by the nature of the group of people which use the machine, and one can put forth the hypothesis that there is a socio-cognitive conflict involved, as established by DOISE, MUGNY and PERRET-CLERMONT, a hypothesis which is the subject of a study currently being carried out. It also appears that technical facility is a factor which varies from one child to another. There are other differences which intervene also, particularly the boy/girl question although there is a considerable divergence of views on this in current studies.

In short, the introduction of a computer brings about series of interactions which create problems for many teachers who have difficulty identifying these issues and therefore considerable difficulty dealing with them. But the essential problem to which we will be referring further on, is that a balance must be found amongst these various interactions.

B. Secondary Effect of the Medium on its Users

A second element which confirms that a tool is not neutral is its capacity to induce information and experience by the way it functions. This is what McLuhan declared in his famous and often misinterpreted saying: "The medium is the message". Many others had analyzed this delicate question before he did. L. MUMFORD showed that the first clocks had created the concept of regularity (1950). C. PARAIN described the way the discovery of the plow had influenced the geometrization of European agriculture (1979). In a recent book, C. POSTAMN (1986) examined the influence of typography on the rhetoric of American preachers in the eighteenth century. P. GREENFIELD (1984) demonstrated the influence of video games on the spacio-visual abilities of the young people who play them. Many authors have examined, in this same light, the influence of television on children. In my opinion, this is a very important question. One could object that television has little to do with computers. This last statement is true according to what I have called a "technological logic". It is not true if one adopts, as I would like to suggest, a "user's logic". In that case, nearly all children who have contact with computers also watch television.

There is one obvious thing that the two technologies have in common: a screen. In my interviews with children I have often been struck by their constant references to television, and this even when they were questioned in school - as if there was, in their memory bank, something that I would call: "screenish". Whereas we, adults, have memory banks based on books. Children have several levels of receptivity to what is presented to them on a screen. Beyond passive consumption there is a level of ritual reception
which has a fairytale type structure. Children check to see that the
goldorak myth is played out in conformity with the accepted schema. One can
put forth the hypothesis that establishing the first relationship with
computers via video games, is adequate for children but not for adults,
because in the case of children it is a way of interacting with the screen,
an object to which they have been exposed since their early childhood. This
would explain the familiarity which they display with personal computer and
that is not observed as such in adults. One observes that they are
delighted to play adventurous games which go beyond the ritual approach to
reading a story. This difference seems important to me, but we do not have
a theoretical explanation for it.

In the hypothesis of a dual continuity (i.e. continuity of the young
person in front of the same grey screen), the use of a computer can be seen
as a mastery of forms on the screen. If this is so, we would be confronted
with a major problem, since, in schools, through use of the screen, we want
them to assimilate content.

C. Use by Teachers

Sporadic innovations do not modify the teacher/student relationship.
One observes in fact a remarkable continuity in the role of a teacher who,
since time immemorial perceives his or her job as that of transmitting
knowledge elaborated by others. This could have opened the way to the use of
didactic material. But it is not the case. The study of the introductions
of computers in fifty-eight secondary schools has shown that teachers use a
didactic computer program only if they can add their own personal touch to
it. Another aspect of the rule of conduct in the teaching profession seems
to be that of direct - and not indirect - contact and this justifies, in my
opinion, the fact that the only universally accepted technique is the
blackboard. Indeed blackboards constitute a compromise between direct verbal
contact and writing - which always implies a sharing of power. Showing
slides also respects this balance. In the nineteenth century, schools
already had numerous boxes of slides with an accompanying commentary to be
read aloud. This technique met with great success. The slide projector has
now been successfully integrated into schools; and tape recorders also
perhaps for the same reason. But the computer does not fall into this same
category: its use implies the delegation of too much power and no possible
direct control by the teacher.

We come back to the idea formulated above: with computers the balance
between the sharing of power and technical facility does no longer
correspond to the norm. We should create new better-balanced products, even
if they appear naive or simple in the eyes of educational researchers and
computer specialists. We must choose between technicality and
practicability, and it is the latter which brings out the notion of
continuity and balance.

If we look at examples of successful innovations, undertaken by
teachers on their own initiative, we observe that they correspond to this
balance pattern. Several years ago, the person who won in France the MICRO
contest on interesting methods was simultaneously a teacher and the
secretary of the local mayor's office. The conjunction of these two functions constituted his originality. At his own expense he had purchased a personal computer to keep the accounts of the mayor's office and to present simple programs to his students in order to help them to conjugate French verbs - a task which he disliked doing himself. The machine could serve well both purposes.

One may find this example a bit picturesque, but it corresponds perfectly to the principle we wish to illustrate concerning the link, within the teaching profession, between direct activity and sharing of technological power; in other terms, the extension of a gesture through a tool, a basic principle in anthropology and in the history of technics.

The introduction of the computer in the classroom has therefore revealed an unexpected number of complex issues. It draws attention both to the numerous interactions that take place between teacher and students and also to the complexity of this social context. Computers and television have considerable influence on the child before he enters school, and later they will be waiting at home for him to return from school! Keyboards are means to enter into contact with screens. The computer constitutes an intrusion in the teacher's work setting, in this universe in which he has established a working pattern and an harmony between various forms of communication in order to have direct influence on his students. But this is not always completely under his control, and this brings us now to the consideration of the overall setting of the school.

2. The Computer in the Overall Setting of an Institution

Observations as those reported above are frequent and encountered in different countries. It is interesting to see whether a macroscopic analysis would lead to the same conclusions. From this point of view two questions are worth examining: one concerns the exact location in which the computer will be used. In this light it is interesting to review the experience of the fifty-eight secondary schools cited above. The second question concerns the instruments that teachers most often use, a matter about which we do not know much.

A. Specific Use Made of Computers in Fifty-Eight Secondary Schools

The "Fifty-eight Secondary Schools" experience lasted ten years. It began as a follow-up of the Colloquium organized in Sèvres by OECD in 1971. It terminated in 1980. Five hundred teachers were involved. The overall budget made it possible to provide equipment for life-long education and extra curricular-activities. It was observed that during the period under consideration, people working in all specialities were interested, to varying degrees, by the possibilities offered by computers and that certain groups, such as those working in mathematics, gradually withdrew from the experiment whereas those working in arts, natural science and physics showed genuine enthusiasm. It should be pointed out that the great majority of teachers volunteered to participate in the experience. One of the
significant results of the operation was the creation of computer clubs in schools. At the outset the promoters of the experience had not intended to create these clubs. Analysing their development, one observes that they are clearly connected with problems of three basic rules of the school system:

- members of the clubs, teachers or students, are all volunteers. This does not conform with the principle of equal status for all.
- club meetings are held after school. This does not conform with the principle of the school period. It is difficult to learn about computers in 55 minutes!
- clubs deal with a variety of subjects and often involve environmental issues. This is not in accordance with the principle of mono-disciplinary teaching.

The place occupied by the computer has more or less become established in the long run, even if certain activities involving computer work do take place during class. Along with this process, ties of mutual interest have been established amongst teachers who share the same interests. This can be interpreted as a retroactive effect of the tool on its setting. Such similar structuring effects on setting are played by the clock or by the plow. The same could be said of the automobile. When the first automobile appeared on the cobblestone streets, at the beginning of the twentieth century, who would have imagined that sixty years later it would have become such an individual mode of transport, modifying our environment as it has, bringing highways, changing housing and lifestyle, affecting deeply our economy, subject to oil crisis.

What we have seen so far does not permit us to consider the computer as a neutral tool. It would therefore be naive to want to introduce it by force into schools and to oblige schools to accept it. We are not the only ones to have reached these conclusions. Certain specialists of educational technology such as GILBERT or PAPERT are of the opinion that educational techniques cannot be introduced unilaterally but that their adoption functions accordingly to a snowball effect. In MINDSTORMS, PAPERT proposes the metaphor of samba school as typical of the new schools which would be dependant on computers. Samba schools are based on the goal of preparing a carnival parade.

We are confronted again with the duality of technical logic and user's logic. The first leads to a binary result: either one uses the computer in school or one does not at all. The second provides other possibilities in accepting to look at what is going on next door. CONFUCIUS said that a good way to make an elephant disappear is to look the other way. I think that in matters of educational technology, we have made a lot of elephants disappear this way, simply because we were looking through the wrong glasses.

Another secondary effect of the introduction of new technologies resides in the development of groups of colleagues who share the same interest in technological experiences. There are numerous examples in France. Teacher training schools, pedagogical movements, associations such as ADEMIR, the EPI or MICROTEL, serve to link a good number of teachers who exchange information, material and experience. This horizontal communica-
tion, due to the computer, is not in conformity with the hierarchical organization or with the educational pyramid.

The analysis of the retroactive effects of technology on the school setting casts an interesting light on the question of how schools evolve. If we want schools to teach what we would call contemporary technological literacy, we then create a rupture with established patterns which have their roots in Roman tradition. In doing so we introduce into the school setting, for the first time in history, industrial tools with their own very specific logic. One of the first things we observe is that their integration, even minimal or partial, in the sense in which we evoked it in Part I, cannot take place if we do not create ballasts, such as spaces for extra curricular-activities or horizontal exchanges.

B. The Real Tools

We know very little about the programs that teachers actually use (or could use) in class, precisely because we have taken so little account of their logic and of the continuity of the school system. From this point of view, the teachers involved in our research, while providing us with theoretical and practical information, also somehow distorted our image of teachers by the fact of their enthusiasm which is not shared by others. In recent years, in spite of the variety of educational software which has been made available, we have seen unexpected use of word processing programs and spreadsheets for elementary exercises. The success enjoyed by LOGO in presenting stereotyped standard exercises to draw a square, a triangle, a house, can be explained in my opinion in this light. One can ask if the possibilities of computer technology should not be revised taking this into account, and if teachers should not be provided with solid simple tools which could be easier to integrate into their educational software. The hypothesis that a simple disk would be used more than several appears to have some validity.

In two studies presently being carried out, one under the CNRS*, and the other by the CEE** in collaboration with the Universities of LIEGE*** and LOUGHBOROUGH****, we see subtle indications as to how new teachers react when a computer is proposed to them, and this should permit us to adjust our approach taking account of these considerations.

This question in fact constitutes a counterproof to the first. On the basis of simple use of a computer, one can examine whether it can ne varietur remain within the school or whether, at a more complex level, some counter-balance must be introduced.

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* with Jean-François Boudinot (INRP), Danielle Boudinot and Claire Terflon (INPR)
** with Danielle Colardyn, Elizabeth Lage, Christian Sautron (Centre de Recherche sur la Culture Technique)
*** D. Leclercq, M. Delhaxe, S. Oesterrieth
**** L. Cohen and D. Blease
The challenge becomes then to manage to evaluate the institutional effects of the computer, depending on the perspective from which one is judging normal functioning of a school. The hypotheses of counter-balance and of linkage systems were developed through user's logic taking into account individual continuity as well as the context in which the equipment is being introduced.

**Conclusion**

Observation of behaviour patterns produced by the introduction of a computer, in the micro-context of a classroom or in the overall context of the school, shows us that it is a complex issue. The instrument itself is only an element of a complex set of interactions. It has influence outside of the school setting, either on its own, or in conjunction with television. It upsets the delicate balance which was established long ago by teachers between oral techniques and technological practices. As a corollary, while certain teachers wish to introduce a computer, a discrepancy appears between its eventual use (subjects, classes) and the time factor. An important question is that of clearly defining what a truly balanced solution would be - something which today can only be a hypothesis. Reflection on the subject suggests that the hypothesis of enlarging the selection of what institutions offer, radically questions the principle of universality of use by all teachers. It must be said that usually, things have been approached the wrong way around, and that teachers cannot be blamed for their hesitations to use these new technologies.

We can ask ourselves whether the question should not be posed the other way around by taking into account the cultural imbalances which tomorrow's schools are going to have to help to solve. One of the most important of these is the overwhelming influence of television on children of all cultural backgrounds. The imbalance it has created is that children no longer know how to distinguish reality from fiction, both of them being presented in the same way on the grey screen. The task will be to teach them the difference between the content and the form of information, whether it is applied to a tangible or imaginary issue. This task does not involve use of the computer as we know it today, nor the critical evaluation of television programs, even if they are helpful. We are entering an age in which the media will play a major rule. It is important to carefully consider the rule schools will have to play in the way information will be disseminated. Can schools play this role without modifying their structures? We will answer negatively to this question if we remember how technical developments have taken place in history. Perhaps we can answer positively if we take care of the patterns described above, if we distance ourselves sufficiently so as to perceive the overall context of the problem and if we take seriously enough the challenge that this issue constitutes - it raises perhaps even the questions of the very existence of schools in the future.
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