DEPARTAMENT DE PSICOLOGIA EVOLUTIVA I DE L'EDUCACIÓ

EFFECTS OF PERSONAL EPISTEMOLOGY BELIEFS, TASK CONDITIONS AND PRIOR KNOWLEDGE ON UNDERSTANDING OF MULTIPLE TEXTS

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Efectos de las creencias epistemológicas, las condiciones de tarea y el conocimiento previo en la comprensión de textos múltiples

Effects of personal epistemology beliefs, task conditions and prior knowledge on understanding of multiple texts

TESIS DOCTORAL EUROPEA PRESENTADA POR: **LAURA GIL PELLUCH**

DIRECTORES: **EDUARDO VIDAL-ABARCA GÁMEZ E IVAR BRÅTEN**

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INTRODUCCIÓN

La lectura, comprensión y empleo de documentos múltiples son actividades cada vez más comunes y demandadas en las sociedades modernas, no únicamente en contextos educativos, sino también en situaciones de la vida diaria y en la mayoría de puestos de trabajo. La lectura de documentos múltiples implica que el lector debe sumar a los procesos asociados a la comprensión de cada texto por separado, el esfuerzo por integrar la información disponible en los diferentes textos. En este proceso de integración de información, el lector puede verse necesitado de estrategias de comprensión específicas que van más allá de las empleadas en la lectura de un texto único. Así, es posible que precise identificar las características de la fuente de cada documento, que necesite contrastar la información que presenta cada uno de ellos con la presentada en otros, al mismo tiempo que interpreta dicha información atendiendo a las características de la fuente pertinente.

La investigación sobre integración de información con documentos múltiples se ha hecho presentando a los estudiantes textos que abordan una misma temática y planteando tareas que demandan integración de información, tales como contrastar la información acerca de la misma noticia presentada en distintos periódicos, tomar decisiones basadas en informes médicos o legales, o argumentar las causas de un hecho histórico empleando la información de varios textos, por poner sólo unos ejemplos. Las operaciones mentales y estrategias que demandan estas tareas resultan muy difíciles de resolver para los estudiantes incluso para aquellos con buenas estrategias de lectura en textos simples (Rouet, 2006). Son varios los estudios que muestran que estudiar un tema concreto con documentos múltiples, en lugar de

hacerlo con un solo texto, beneficia el aprendizaje de los estudiantes. Sin embargo, el simple hecho de estudiar con varios textos, no garantiza que estudiantes inexpertos en el manejo de documentos múltiples se beneficien de tal actividad. Aunque la mayoría de estudios del área han sido realizados con adultos, los pocos estudios que existen con estudiantes de primaria y secundaria coinciden en afirmar que la lectura con documentos múltiples es una actividad compleja de la que los estudiantes más jóvenes no son capaces de beneficiarse sin una instrucción previa en las estrategias que se asocian al empleo de documentos múltiples.

Dentro de este contexto, en la presente investigación estamos interesados en conocer qué tareas son las más adecuadas para promover la comprensión e integración de documentos múltiples y qué características del lector pueden interactuar con la tarea moderando su efecto en dichos procesos. Por medio de una serie de estudios, el primero con enfoque correlacional y los dos siguientes con enfoque experimental, examinaremos el efecto de dos de las tareas más comunes para aprender con documentos que guardan una relación temática, i.e. los resúmenes y los ensayos argumentativos. Además, analizaremos el papel de dos variables individuales que a priori parecen tener una relevancia clara en estas tareas: las creencias epistemológicas y el conocimiento previo de los estudiantes.

En el marco teórico de esta tesis, capítulo 1, se realiza una breve revisión de la literatura actual en un intento de proporcionar una visión global acerca de los puntos de consenso y divergencia de la comunidad científica sobre cuestiones de interés en el estudio de documentos múltiples. En primer lugar, se abordan cuestiones nucleares y tradicionalmente debatidas, como las diferencias que existen entre los procesos y estrategias implicados en la comprensión de un texto aislado y los implicados en la comprensión de textos múltiples y las diferencias en el modo en que se construye la representación de la información en la memoria. Así, examinaremos el modelo cognitivo de Construcción-Integración propuesto por Kintsch (1988, 1998) para

explicar cómo el lector alcanza la comprensión de un texto único y el propuesto por Rouet, Britt, Masson y Perfetti (1996) que describe cómo el lector produce la representación mental de documentos múltiples sobre un tema concreto.

Continuaremos revisando las investigaciones que han analizado los efectos en el aprendizaje del estudio con documentos múltiples y aquéllas que comparan el papel que ejercen las diferentes tareas de integración en dicho aprendizaje. Profundizando en esta última cuestión, revisaremos los pocos estudios que se han realizado hasta el momento para aclarar la influencia de ciertas variables individuales (i.e. creencias epistemológicas y conocimiento previo) y textuales (i.e. modo de presentación de la información) en el efecto sobre el aprendizaje de las tareas con documentos múltiples.

En la segunda parte del trabajo se expone el cuerpo empírico de la tesis. Consta de tres estudios presentados a modo de artículo científico. Cada uno de ellos, comienza con una revisión teórica de la literatura actual acerca de las variables específicas que investiga el estudio, para seguidamente describir la metodología empleada y los resultados obtenidos. Finalmente, los estudios discuten las principales conclusiones alcanzadas así como sus limitaciones e implicaciones educativas.

El capítulo 2 presenta un estudio de corte descriptivo, correlacional y transcultural que explora la dimensionalidad de las creencias epistemológicas de los estudiantes a nivel de conceptos científicos específicos (i.e. el cambio climático). Además, analiza la relación de la epistemología personal con el conocimiento previo y el interés evaluados al mismo nivel de especificidad así como el género y edad de los participantes. Por último, se discuten las diferencias respecto a los resultados hallados en un estudio paralelo realizado en Noruega.

El capítulo 3 incluye un estudio experimental que analiza el efecto de la tarea (ensayo argumentativo vs. resumen) en la comprensión e integración de varios documentos acerca del cambio climático y su interacción con la epistemología personal. Para la evaluación de las creencias epistemológicas de los estudiantes, se

sirve de las conclusiones alcanzadas en el estudio que le precede. Finalmente, el capítulo 4 presenta un estudio compuesto por dos experimentos cuyo diseño experimental fue motivado y guiado por los resultados inesperados que hallamos en el estudio que presenta el capítulo 3. En el primer experimento de este estudio, analizamos si el efecto de la tarea en la comprensión e integración de información presentada en los documentos puede ser dependiente de algunas de las características que definen la situación de aprendizaje (i.e. modo de presentación de la información y cantidad de información a integrar), mientras que en el segundo experimento exploramos la posibilidad de que el efecto de tarea dependa del nivel de conocimiento previo de los estudiantes.

CAPÍTULO 1

Marco Teórico

1.1. COMPRENSIÓN DE TEXTOS ÚNICOS: EL MODELO DE CONSTRUCCIÓN-INTEGRACIÓN.

Comprender la información de textos múltiples sobre un aspecto concreto no es exactamente igual que comprender un texto único, sino que implica procesos adicionales que van más allá de la lectura de textos únicos. Ahora bien, para crear un marco teórico y acercarnos a qué es lo que se ha estudiado sobre comprensión de textos múltiples parece lógico comenzar por concretar qué es lo que entendemos por comprensión de información de un texto.

De acuerdo con el modelo de Construcción-Integración formulado por Kintsch (1988, 1998) la comprensión podría definirse como la construcción de una representación mental coherente o modelo situacional a partir de la situación descrita en el texto (van Dijk y Kintsch,1983). La construcción de esta representación mental implica un conjunto de subprocesos que el lector ha de llevar a cabo en diferentes

ciclos de procesamiento, tales como la construcción de ideas elementales o proposiciones a partir de las ideas presentes en el texto, la integración de la información textual con el conocimiento previo del lector y la generación de varios tipos de inferencias (Kintsch y van Dijk, 1978, Kintsch, 1998).

Según este modelo, el lector procesa el texto en ciclos sucesivos. Cada ciclo se corresponde aproximadamente con una frase del texto. En cada ciclo el lector lleva a cabo una serie de procesos mentales que le permiten ir formando una representación mental del texto. Así, en cada ciclo, el lector forma proposiciones a partir de las expresiones del texto y las conecta unas con otras formando una especie de red. Las ideas creadas a partir del texto activan asimismo ideas del conocimiento previo del lector que también se añaden a la red (i. e., inferencias basadas en el conocimiento). Otro de los procesos que el lector lleva a cabo en cada ciclo de procesamiento es la formación de macroproposiciones o ideas que sintetizan la información más importante de cada ciclo. Finalmente, el lector forma un último tipo de ideas, las llamadas inferencias-puente, que se definen como ideas que establecen conexiones entre ideas textuales haciendo uso de claves sintácticas.

Todas estas ideas se conectan formando una red que ha de ser integrada y que, en términos del modelo de Construcción-Integración, implica suprimir la información no pertinente y reducir la red a un conjunto coherente de proposiciones. Esta red inicial se almacena en la memoria a largo plazo, para dejar espacio en la memoria de trabajo y permitir al lector realizar un nuevo ciclo de procesamiento. Tan solo unas pocas ideas formadas en el ciclo previo, idealmente la/s macroproposición/es, se mantienen activas en la memoria de trabajo, con el fin de servir de nexo de conexión con el siguiente ciclo de procesamiento, puesto que debido a las limitaciones de memoria operativa no sería posible mantener todas las ideas formadas en el ciclo previo. Un nuevo ciclo de procesamiento comenzaría con la lectura de la siguiente frase del texto, y el lector repetiría los procesos ya comentados:

formaría nuevas ideas textuales, activaría conocimientos previos, haría inferencias y construiría una nueva macroproposición. La conexión de ideas del ciclo anterior con las del nuevo ciclo se asegura con la incorporación de ideas del ciclo previo al nuevo ciclo procesamiento. Dicha conexión se puede realizar directamente por repetición de términos textuales o indirectamente mediante la formación de inferencias que conectan el conocimiento previo del lector con las ideas del texto. El proceso continúa con la formación de ciclos sucesivos, y de esta forma, se va construyendo una representación mental del texto, a modo de red de ideas interconectadas.

Cuando la comprensión de un texto se realiza correctamente, el lector va formando inferencias que conectan las diferentes ideas del texto con su conocimiento previo. Cuantas más inferencias realice, más integrada estará la red con el conocimiento que poseía el lector. Esto nos lleva a la distinción de Kintsch entre dos niveles de procesamiento: *base del texto* y *modelo de la situación*. La base del texto consiste en una representación mental del texto que incorpora únicamente ideas y relaciones derivadas del propio texto, sin añadir nada que no estuviera explícito en el mismo. Generalmente, el resultado es una red pobre e incoherente. El modelo de la situación hace referencia a una representación en la que la información del texto se conecta con los conocimientos previos del lector. No se trata de una representación distinta a la que constituye la base del texto, sino un nivel diferente de comprensión, en la que el lector incorpora a la base del texto ideas procedentes de su memoria a largo plazo y establece nuevas conexiones. Son varios los tipos de conocimiento que el lector emplea al construir su modelo de la situación; i.e. conocimiento sobre el lenguaje, sobre el mundo en general, y sobre el tema específico que trata el texto. Las condiciones que promueven la construcción de un modelo de la situación, a diferencia de las que promueven un procesamiento superficial del texto devienen en un mejor aprendizaje (Kintsch, 1994).

Limitaciones del Modelo de Construcción-Integración

El modelo de Construcción-Integración es un modelo teórico ampliamente aceptado para explicar cómo el lector alcanza la comprensión de un único texto que, asimismo, ha sido apoyado por numerosas investigaciones experimentales (p.ej. Ericsson y Kintsch, 1995, Glenberg, Mayer y Lindem, 1987, Morrow, Greenspan, y Bower, 1987). Sin embargo, este modelo se apoya en una serie de asunciones relativas a la naturaleza del texto y al propósito de lectura excesivamente restringidas que limitan la aplicación del modelo a un contexto de lectura aislado y aséptico. Dichas asunciones impiden que el modelo pueda mantenerse para explicar cómo el lector alcanza la comprensión de lo leído en situaciones de lectura más complejas y realistas, como es el caso de las tareas de integración con documentos múltiples.

Tres son las limitaciones básicas que Rouet (2006) advierte en el modelo propuesto por Kintsch. Primero, el modelo de Construcción-Integración descansa en la asunción de que los textos son representaciones lingüísticas de situaciones y define la comprensión como el proceso de construcción de la representación mental de la situación que es descrita en el texto. Esta asunción puede ser válida para los textos narrativos (ampliamente empleados por los experimentos derivados del modelo) donde apenas cabe interpretación por parte del lector y la situación que construye el lector es fiel a lo descrito en el texto. Sin embargo, en la mayoría de circunstancias de lectura, las características que definen la fuente del texto (p. ej. quién dijo qué, a quién, cuándo, dónde y con qué propósito) juegan un papel determinante en la representación del texto, creando una distancia entre el texto concreto y el modelo de la situación creado por el lector. Así, la representación mental del texto que finalmente construye el lector es dependiente de las inferencias que haya realizado durante la lectura relativas a las relaciones que existen entre el contenido del texto y las características de su fuente.

Segundo, el modelo se centra en la comprensión de textos únicos y asume que el lector alcanza la integración de las diferentes partes de un mismo texto guiado por principios de coherencia. En ninguna de sus premisas, el modelo describe cómo se lleva a cabo el proceso de integración que tiene lugar cuando el lector se enfrenta a una tarea con documentos múltiples. En este tipo de tareas, la integración de información se presenta a los estudiantes como especialmente compleja por el hecho de que muchas veces los textos presentan información contradictoria acerca de una misma temática que debe ser detectada por el lector y representada en su memoria. El lector, en su esfuerzo por crear una representación de la información descrita en los textos, no puede servirse únicamente de los principios de coherencia propuestos en el modelo de Kintsch para integrar información, por el simple hecho de que los textos presentan información contradictoria. Así, para que el lector forme una representación coherente de la situación descrita en los textos, es necesario que incorpore a su modelo de la situación cierta información acerca de la fuente de cada uno de los textos y que, además, relacione dicha información con el contenido de los textos. Es decir, necesita valerse de nuevas estrategias de lectura que no se contemplan en el modelo de Construcción-Integración.

Por último, la tercera limitación que Rouet (2006) atribuye al modelo de Construcción-Integración, hace referencia a lo no inclusión del contexto de lectura como factor determinante en el proceso de comprensión. Así, las particularidades del contexto en el que se enmarca la comprensión de uno o varios textos, tales como el propósito de lectura y las condiciones que definen la tarea de lectura, tampoco son contempladas en el modelo de Kintsch. Sin embargo, los estudios que han investigado el papel del contexto de lectura han mostrado que éste posee una relevancia clara en la organización y naturaleza de las estrategias que emplean los lectores (p.ej. Lorch, Lorch y Klusewitz, 1993; Kirsch, Jungeblut, Jenkins y Kosltad, 2002).

Es el contexto de tarea el que, por ejemplo, informa al lector de si el contenido de un texto requiere ser interpretado atendiendo a las características de su fuente (Britt y Aglinskas, 2002; Britt, Rouet, Georgi, y Perfetti, 1994), el que modula la velocidad de lectura que el lector dedica al procesamiento de una y otra parte del texto en función de su pertinencia para las demandas de la tarea (Cerdán y Vidal-Abarca, 2008), o el que determina si el lector ha de leer el texto de principio a fin o alternativamente, emplear estrategias específicas para la búsqueda de información que le permitan localizar lo más rápidamente posible la información que necesita para resolver la tarea (Cerdán et al., en prensa; Mañá et al., en revisión; otro en preparación).

Estas tres limitaciones le sirven a Rouet (2006) para cuestionar los modelos tradicionales de comprensión y como argumentos para defender que son necesarios nuevos modelos que expliquen cómo el lector alcanza la comprensión de un texto en situaciones de lectura más realistas. Según Rouet, los nuevos modelos deberían reconsiderar la naturaleza de la interacción que se establece entre personas y textos e incluir el contexto de lectura como uno de los factores clave en los procesos de comprensión. Demandan, por tanto, un salto cualitativo de las teorías tradicionales centradas en la interacción *lector-texto* a teorías más extensas y naturalistas que consideren el proceso de comprensión como el resultado de la triple interacción *contexto-texto-lector*.

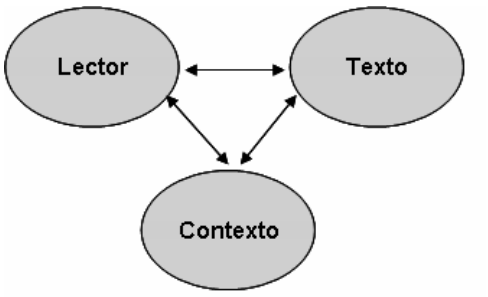

Figura 1.1. Interacción contexto-texto-lector

Estas teorías deberían explicar no sólo cómo el lector representa la situación descrita en el texto (o los textos) sino también cómo representa el contexto en el que la lectura tiene lugar. Son múltiples las variables que pertenecen al contexto de lectura y que son determinantes en la representación mental que el lector realiza. Estas incluyen las características espaciales y temporales que definen el contexto de lectura, el propósito de la tarea de lectura y sus consecuencias para el lector, y los objetivos y perspectivas del material de lectura. Las variables contextuales son especialmente importantes en las tareas con documentos múltiples: el momento y lugar en que se leen determinados documentos condicionan la interpretación que el lector hace de los mismos, el propósito de la tarea de lectura y sus consecuencias determinan la cantidad de esfuerzo que dedica a procesar los documentos, y los objetivos y perspectivas que definen cada documento influyen en la importancia y credibilidad que el lector les confiere.

El cuerpo experimental de este trabajo adopta el enfoque de la triple interacción *contexto-texto-lector* propuesto por Rouet (2006) y Snow (2002) y estudia cómo las variables contextuales intervienen en los procesos de comprensión e integración, y como éstas interaccionan con variables cognitivas del lector y las características textuales. Así, haciendo que los estudiantes lean los mismos textos con propósitos de lectura diferentes (i.e. leer para resumir vs. leer para argumentar) estudiaremos el papel que ejerce el contexto en la comprensión e integración de información. Al mismo tiempo, evaluando algunas de las diferencias individuales de los lectores (i.e. las creencias epistemológicas y el conocimiento previo) analizaremos el efecto de las características del lector. Finalmente, haciendo que los estudiantes lean los textos variando el modo de presentarles la información y el número de documentos, estudiaremos la influencia de alguna de las variables textuales en los procesos de comprensión e integración.

1.2. COMPRENSIÓN DE TEXTOS MÚLTIPLES: EL MODELO DE DOCUMENTOS

La experiencia nos dice que ante una determinada tarea de integración con varios textos referidos a un mismo tema, puede ocurrir que el lector construya un modelo de la situación independiente para cada uno de los textos, o que, alternativamente, el lector construya un modelo de la situación totalmente integrado que combine la información de los diferentes textos. Así mismo, puede ocurrir que el lector cree un modelo más o menos integrado, a medio camino entre los modelos independientes y el modelo totalmente integrado.

Rouet, Britt, Masson y Perfetti (1996) han propuesto un modelo cognitivo que describe cómo el lector experto produce la representación de varios documentos referidos a un mismo tema en la memoria. Este modelo, basado en el de Kintsch (Kintsch, 1988, 1998), y al mismo tiempo conducido por las limitaciones que le han sido atribuidas para explicar situaciones de lectura realistas, intenta explicar los procesos y estrategias implicados en las tareas de integrar información procedente de documentos que fueron elaborados separadamente. Los autores sugieren que la comprensión de documentos múltiples implica a nivel local los mismos niveles de procesamiento que la comprensión de un único texto. Es decir, para cada texto, el lector ha de entender el significado literal del texto y elaborar su propio modelo de la situación.

Sin embargo, dado que los textos pueden relacionarse de varias formas, presentando información solapada, complementaria e incluso contradictoria, los modelos de la situación elaborados a partir de ellos, pueden interactuar también de varias formas. Esto es, los modelos pueden coincidir, es decir, un modelo puede formar parte del modelo de la situación de otro documento y asimismo, los diferentes documentos pueden producir modelos de la situación incompatibles. Por ello, cuando el aprendizaje se produce a partir de documentos múltiples los lectores construyen un nivel de representación adicional, donde las diferentes fuentes y los contenidos del

conjunto de documentos están representados, construyendo lo que los autores denominan el *Modelo de Documentos*. Este modelo debe ser válido para argumentar las relaciones entre los diferentes documentos y permitir al lector mantener interpretaciones contradictorias de unos mismos hechos en una representación coherente ya que esas interpretaciones proceden de diferentes autores. Así, el Modelo de Documentos incluye dos componentes o submodelos: el *Modelo Intertexto* y el *Modelo de las Situaciones.*

El Modelo Intertexto representa la información relevante de cada texto, incluyendo los contenidos que se describen en el texto, información sobre la fuente (autor, año, estilo lingüístico) y los objetivos retóricos del documento (audiencia a quien va dirigido y propósito del autor), así como las relaciones que existen entre los textos (de oposición, de acuerdo, referencias a otros textos nombradas en el propio texto).

El Modelo de las Situaciones representa las situaciones, hechos y eventos que se describen en los textos. Algunas partes del Modelo de las Situaciones pueden estar conectadas con el Modelo Intertexto, por ejemplo, cuando los diferentes textos aportan explicaciones contradictorias para un mismo hecho. Cuando el lector construye un Modelo de Documentos completo e integrado, dicho modelo no representa una única situación, sino un conjunto de situaciones ligadas o interconectadas a unos documentos concretos que las apoyan.

Los objetivos del lector y la tarea en la que está implicado durante la lectura de los documentos afectan a la construcción del Modelo de Documentos. La naturaleza de la tarea condiciona la forma en que los lectores leen, memorizan y evalúan la información de los documentos. Las tareas que piden al estudiante que compare documentos, que cite los argumentos de algún autor específico o que describa una situación contradictoria a partir de los documentos disponibles promueven que el lector atienda a las conexiones entre los textos, elabore su Modelo Intertexto y el

consecuente Modelo de los Documentos. Sin embargo, otras tareas como la elaboración de un listado de hechos o la contestación a preguntas específicas, al no requerir que el lector desarrolle un Modelo Intertexto, devienen en la construcción de un Modelo de Documentos relativamente empobrecido, en el que sólo se incluyen situaciones.

El marco propuesto por Rouet et al. (1996) surgió de los estudios realizados con textos de historia que presentaban datos contradictorios acerca la adquisición del Canal de Panamá en el año 1903 por parte de los Estados Unidos; por ello, es un modelo que se adapta muy bien a la representación que el lector genera cuando lee textos de historia. Sin embargo, cuando se trata de explicar los procesos asociados a la lectura de textos científicos, como es el caso de esta investigación, la adecuación del modelo no resulta tan eficiente.

Los textos de historia que abordan un mismo hecho histórico se caracterizan por adoptar puntos de vista específicos que les llevan a interpretaciones particulares, e incluso a contradicciones. Por ello, cuando los estudiantes se enfrentan a la lectura de varios documentos sobre un tema de historia han de tener muy presente qué es lo que cada autor o documento dice y si existe controversia entre las diversas opiniones (Britt y Aglinskas, 2002; Britt, Rouet, Georgi, y Perfetti, 1994; Nokes, Dole, y Hacker, 2007; Rouet et al., 1996; Rouet, Favart, Britt, y Perfetti, 1997; Wiley y Voss, 1999; Wineburg, 1991, 1994; Wolfe y Goldman, 2005). Sin embargo, cuando se leen textos científicos en torno a un mismo tema, la información de los diferentes textos suele ser complementaria. No es tan usual encontrarse documentos contradictorios, sino informaciones que complementan o explican con más detalle los contenidos de otro documento. La integración de información procedente de varios documentos científicos es un tema que ha sido mucho menos estudiado (Bråten y Strømsø, 2003; Cerdán y Vidal-Abarca, 2008; Gil et al, 2008), a pesar de ser una actividad muy frecuente en la educación secundaria y universitaria. A priori, cando se leen textos

científicos no importa tanto atender a las interpretaciones de los diversos autores, explicar esas diferentes interpretaciones o mencionar las fuentes, como reconocer qué información es pertinente y qué contenidos complementan a otros leídos previamente.

Las razones que argumentan la falta de adecuación del modelo para explicar los procesos de comprensión e integración de información de documentos científicos son varias. En primer lugar, es frecuente que durante el estudio de textos científicos sobre un tema el lector no necesite desarrollar el Modelo Intertexto para alcanzar el éxito en la tarea que le ocupa. Esto es, la información que se representa en el modelo Intertexto referente a las características de las fuentes no es tan relevante para la construcción de la representación mental que ha de crear el lector para comprender e integrar la información de textos científicos. En segundo lugar, es posible que tampoco necesite establecer conexiones entre los diferentes textos que conecten interpretaciones contradictorias de un mismo evento o concepto. Sin embargo, el lector debe ser capaz de reconocer la información pertinente de un texto, detectar aquella que ya conoce porque la ha leído en otro texto, aunque con otras palabras y aquella que es nueva y complementa a otra información que aprendió previamente. Y, finalmente, debe ser capaz de construir una representación mental coherente que combine la información de los diferentes textos. Por tanto, no es tan importante formarse un modelo mental del contenido de los diferentes textos, interpretar los textos atendiendo a las características de su fuente y establecer conexiones entre ellos, como localizar y seleccionar la información relevante de cada texto y combinar esta información en una representación global coherente.

Rouet et al. (1996) establecieron una distinción entre dos conceptos que se ajusta a las diferencias que se dan al estudiar con textos históricos y textos científicos. Sostienen que no es lo mismo *Razonar sobre documentos* que *Razonar con documentos.* Razonar sobre documentos implica que, cuando se aprende con documentos múltiples, puede existir la necesidad de evaluar cada segmento de

información de un documento teniendo muy en cuenta el tipo y las características del documento que se está estudiando. Esta es una habilidad muy importante al trabajar con textos de historia. Sin embargo es menos importante cuando se trabaja con textos expositivos, en los que no es tan importante especificar quién o cuándo dijo qué, cuanto aportar evidencia de los hechos que se están estudiando. Por otro lado, Razonar con documentos hace referencia a la habilidad para usar la información de un documento para resolver un problema, tal como elaborar un ensayo o redacción sobre un tema o responder a una cuestión específica a partir de documentos múltiples. Esta sí es una habilidad básica y necesaria para combinar la información presentada en varios textos científicos que implica entender textos que han sido elaborados por autores diferentes con propósitos específicos, e integrar la información proveniente de esos textos.

1.3. EL APRENDIZAJE CON DOCUMENTOS MÚLTIPLES

Otro tema que han abordado los investigadores del área ha sido el efecto que la lectura y empleo de documentos múltiples ejerce sobre el aprendizaje. Son varias las investigaciones que muestran que estudiar con documentos que fueron elaborados separadamente beneficia el aprendizaje y la comprensión de los estudiantes (p. ej. Britt y Aglinskas, 2002; Bråten y Strømsø, 2006a; Nokes et al., 2007; Wiley y Voss, 1999). No están claras las razones de este beneficio, pero la explicación más aceptada por los investigadores hace referencia a que el estudio con documentos múltiples fomenta el empleo de estrategias y operaciones mentales que promueven la construcción de una representación mental más compleja y flexible de la información mental que el estudio con un único texto. Sin embargo, los resultados de investigaciones recientes muestran que el simple hecho de estudiar con varios textos no asegura el beneficio sobre el aprendizaje de todos los estudiantes, tal como veremos más adelante. Primeramente examinaremos algunos estudios que demuestran beneficios sobre el aprendizaje.

Wiley y Voss (1999) realizaron dos experimentos para estudiar las diferencias que produce sobre el aprendizaje y la comprensión de un evento histórico el hecho de estudiar con varios textos o con un único texto. La mitad de los estudiantes que participaron en los experimentos disponía de varios documentos con información sobre la historia de Irlanda entre 1800 y 1850 que les fueron presentados en un entorno web (un mapa, una biografía, documentos explicativos de determinados eventos y datos del censo de población). Dicho entorno permitía a los estudiantes consultar uno o dos documentos al mismo tiempo y elegir el orden de lectura de los diferentes documentos. Sin embargo, la otra mitad disponía de la misma información pero presentada a modo de capítulo de libro, es decir, en un único texto. La tarea de los estudiantes en ambas condiciones consistía en elaborar un ensayo argumentativo, una narración, un resumen o una explicación de los hechos que habían leído. En todos los casos debían concretar las causas del significativo cambio que se produjo en la población de Irlanda entre 1846 y 1850. Se les permitió consultar los documentos mientras escribían su redacción. Los estudiantes que consultaron la información en forma de documentos múltiples alcanzaron un nivel superior de comprensión de los textos y elaboraron ensayos con niveles superiores de transformación, integración y causalidad. Los autores explican este resultado en términos de niveles procesamiento. Mientras las tareas con documentos múltiples promovían la construcción de un modelo de la situación, las tareas con textos simples promovían un procesamiento más superficial del texto.

Perfetti, Britt y Georgy (1995) sostienen que el aprendizaje a través de documentos múltiples afecta a la capacidad de razonamiento de los estudiantes. Estudiaron a un grupo de estudiantes que durante un periodo de ocho semanas leyó un conjunto de documentos sobre la construcción del Canal de Panamá. Encontraron que según avanzaban en la lectura de los textos, el razonamiento de los estudiantes se hacía más complejo. Eran capaces de justificar más adecuadamente sus

afirmaciones, y usaban cadenas causales más largas. Los autores discuten que el incremento en la calidad de razonamiento de los estudiantes podía deberse a la exposición a documentos múltiples así como a un incremento en el conocimiento sobre el tema.

Rouet et al. (1996) también encontraron evidencia de que el empleo de documentos múltiples al estudiar temas de historia beneficia el aprendizaje de los estudiantes. El empleo de fuentes primarias en el aprendizaje de un evento histórico ayudó a sus estudiantes a combinar y relacionar la información disponible, aumentó la calidad de los ensayos y promovió el empleo de referencias a las fuentes.

Las explicaciones a este beneficio las encontramos en las investigaciones que se han esforzado en indagar cuáles son los procesos y estrategias asociadas al proceso de integración que promueven el aprendizaje de los estudiantes. Así, hoy sabemos que mientras ciertos aspectos asociados al proceso de integración son de naturaleza más o menos automática, como es el caso de la integración que se produce cuando la información de un texto se solapa con la información de otro texto (Kurby, Britt, y Magliano, 2005), existen otros aspectos que requieren la activación de ciertas estrategias por parte del lector.

Wineburg (1991), en un estudio motivado por la necesidad planteada por muchos profesores de historia de enseñar empleando documentos múltiples, analizó cuáles son las estrategias que emplean los historiadores para integrar la información presentada en documentos separados con el propósito de guiar a los profesores en el proceso de enseñanza. Wineburg distinguió tres estrategias ampliamente empleadas por los expertos en tareas de integración de información: (a) *evaluar la información de la fuente* que implica identificar las características críticas que definen un documento (i.e. autor del texto, fecha en que fue escrito el documento, tipo de documento, estilo lingüístico, audiencia a quien va dirigido) e interpretarlo atendiendo a dichas características; (b) *contextualizar* entendido como situar en el tiempo y el espacio los

eventos o hechos que se describen en el documento y (c) *corroborar*, estrategia que emplean los expertos para comparar la información presentada en las diferentes fuentes, y especificar si esta información es coincidente o contradictoria

Rouet et al. (1997) se preguntaron si estas estrategias eran exclusivas de los historiadores, o si por el contrario, su uso abarcaba también a otras disciplinas. En su estudio, comprobaron que estudiantes universitarios con poca experiencia previa en textos de historia también mostraban algunas de las habilidades que Wineburg atribuyó a los expertos. Estudiantes de psicología familiarizados con el empleo de fuentes primarias y secundarias en su área de conocimiento (psicología) se beneficiaron del empleo de documentos múltiples en el área de historia. Fueron capaces de atender a diferentes fuentes sobre un tema de historia y de integrar la información de los documentos en un ensayo coherente. Los autores concluyeron que el uso de estrategias como la corroboración o la evaluación de las fuentes es una cuestión de depende más del nivel de experiencia en el manejo de documentos, que del nivel de conocimiento previo en el dominio que implica a la tarea de integración.

Otra interesante aportación referente a cuáles son los procesos y estrategias que se ponen en marcha durante el proceso de integración fue la realizada por Mannes (1994) y Mannes y Hoyes (1996). Según estos autores, cuando los lectores integran información procedente de diferentes documentos emplean la estrategia de *restablecimiento-integración*: i.e. durante el procesamiento de un texto, cuando reconocen información que leyeron en otras fuentes, la proposición que representa esta información se activa en la memoria de trabajo junto con otras relacionadas que se aprendieron anteriormente. Al coincidir al mismo tiempo en la memoria operativa la información que se está leyendo y la que se leyó anteriormente, el lector puede establecer conexiones entre su conocimiento previo y la información que está leyendo mediante inferencias o elaboraciones. Sin embargo, los autores afirman que este proceso no siempre se produce automáticamente y parece depender de las

características de la tarea en la que está envuelto el lector. Los autores llegaron a esta conclusión a partir de los resultados encontrados en dos experimentos en los que dos grupos de estudiantes leían un esquema con una perspectiva que coincidía o no con la perspectiva de un texto expositivo que leían a continuación (Mannes, 1994). Únicamente la versión del esquema con una perspectiva diferente a la del texto representaba una fuente de información diferente y por tanto, era la única condición de tarea que demandaba la integración de información entre fuentes de información independientes. Los participantes, tras la lectura del texto pasaban, una serie de pruebas de aprendizaje: una tarea para establecer relaciones entre ideas, una tarea de memoria señalizada y un resumen. El grupo que tenía el esquema con una perspectiva diferente a la presentada en el texto incluyó más ideas del esquema en el resumen y estableció más relaciones entre los contenidos de las dos fuentes, creando una representación mental de la información textual más rica y flexible. La lectura de las dos fuentes que no presentaban la misma estructura promovía que el lector estableciera relaciones entre ambas fuentes mediante la estrategia de *restablecimiento-integración* asegurando con ello un procesamiento más profundo del material textual.

Además, Mannes y Hoyes (1996) encontraron evidencia on-line de la estrategia de *restablecimiento-integración* en términos de tiempos de lectura. Los lectores cuyo esquema y texto presentaban perspectivas diferentes leyeron la información más despacio que los lectores cuyo material presentaba una única perspectiva, a pesar de que los esquemas de ambos grupos incluían la misma información. La explicación que los autores aportan a este patrón de lectura es que los lectores con diferentes perspectivas necesitan un tiempo extra para contrastar e integrar la información de las dos fuentes. Por otro lado, encontraron que los estudiantes que se encontraban en la situación de perspectivas diferentes leían más despacio la información que era nueva. Este resultado también apoya la activación de la estrategia de *restablecimiento-*

integración, porque cuando los lectores se encuentran con información nueva han de activar la información que tenían en la memoria a largo plazo para contrastarla con la nueva información.

Una de las aproximaciones más importantes a la cuestión que nos ocupa ha sido la realizada por Strømsø, Bråten y Samuelstuen (2003). Estos autores estudiaron las estrategias on-line que emplean los estudiantes cuando se enfrentan a la lectura de textos expositivos múltiples mediante metodología de pensar en voz alta. Encontraron que los estudiantes empleaban principalmente 4 estrategias cuando leen textos múltiples: (a) la estrategia de memorización que ocurre cuando el lector aporta evidencia de seleccionar o repetir información textual, sin transformar el contenido del texto, lo que da lugar a estrategias tales como la copia o el subrayado de información textual ; (b) la estrategia de elaboración que implica los intentos por parte del lector de hacer el texto más significativo mediante la elaboración de conexiones entre ideas textuales o entre ideas y el conocimiento previo del lector; son ejemplos de esta categoría el establecimiento de analogías, la descripción de experiencias personales o conectar ideas del texto con ideas de otras fuentes; (c) la estrategia de organización que se da cuando el lector agrupa, relaciona u ordena la información del texto, lo que se manifiesta en la creación de mapas conceptuales o en la elaboración de resúmenes o esquemas y (d) la estrategia de monitorización que se da cuando el lector evalúa o regula la comprensión del texto. Esta categoría incluye confirmaciones de estar comprendiendo el texto y la detección y solución de problemas de comprensión. Los autores destacaron dos resultados principales en el análisis del empleo de estas categorías. Mientras las estrategias de memorización y organización eran empleadas para procesar la información de un texto, las estrategias de monitorización y elaboración eran empleadas para establecer conexiones entre el texto que estaban leyendo y otros textos. Además, fueron los estudiantes que focalizaron sus estrategias de elaboración y organización en las fuentes externas los que obtuvieron mejores

resultados en el examen final. Los autores explicaron estos resultados en términos de niveles de procesamiento. Cuando los lectores hacían uso de las estrategias de elaboración y monitorización para relacionar el contenido de diferentes documentos se fomentaba la creación del modelo de la situación en mayor medida que la construcción de la base del texto.

Finalmente, Wolfe and Goldman (2005) también emplearon metodología de pensar en voz alta para estudiar el procesamiento que mostraban estudiantes de secundaria durante la lectura de dos textos acerca de la caída de Imperio romano. Encontraron que los participantes de su estudio empleaban auto-explicaciones que conectaban el contenido de dos textos para integrar la información.

En resumen, estos estudios muestran que los expertos en el manejo de documentos múltiples y los estudiantes universitarios emplean estrategias complejas y específicas para integrar información y que además, estas estrategias promueven que realicen un procesamiento más profundo del material textual y que construyan una representación mental más sofisticada y flexible. Sin embargo, no ocurre lo mismo cuando estudiantes más jóvenes, inexpertos en el estudio con documentos múltiples, se enfrentan a una tarea de integración.

Por ejemplo, Wineburg (1991) encontró que los estudiantes de secundaria no empleaban espontáneamente las estrategias que manifestaron los historiadores, sino que tendían a tratar la información de cada documento como piezas de información independiente y apenas prestaban atención a las características de las diferentes fuentes. En concordancia con este resultado, Stahl, Hynd, Britton, McNish, y Bosquet (1996) aportaron evidencia referente a que los estudiantes de secundaria no muestran espontáneamente las estrategias propuestas por Wineburg. En su investigación, un grupo de estudiantes leyó un conjunto de documentos acerca de un incidente ocurrido durante la Guerra de Vietnam. Encontraron que los participantes del estudio no se beneficiaron de la lectura con más de dos textos, probablemente debido a su limitado

conocimiento sobre las diferentes clases de documentos históricos. Del mismo modo, VanSledright y Kelly (1998), en un estudio con varios textos de historia, observaron que estudiantes con edades comprendidas entre los 10 y los 12 años tendían a estudiar los documentos tratando de acumular tanta información como les fuera posible sin esforzarse por integrar o combinar la información de los documentos, aunque sí mostraron tener conciencia de la diversidad en los puntos de vista representados en cada una de las fuentes.

En conjunto, las investigaciones realizadas con estudiantes de primaria y secundaria sugieren que, aunque estos estudiantes poseen potencial para desarrollar las estrategias asociadas al estudio con documentos múltiples, cuando se enfrentan a tareas de integración de información tienden a no emplearlas de manera espontánea. De acuerdo con Strømsø y Bråten (en prensa), la dominancia del libro de texto como principal fuente de estudio en la educación primaria y secundaria puede explicar por qué la mayoría de los estudiantes de primaria y secundaria tienen dificultades para resolver estas tareas.

Por otro lado, estos estudios añaden que es necesario que los estudiantes posean buenas habilidades en la lectura de textos únicos para poder beneficiarse de la lectura con varios documentos (Britt, Perfetti, Sandak, y Rouet, 1999; VanSledright, 2002). Los estudiantes que arrastran problemas de decodificación o comprensión de textos únicos necesitan concentrar sus esfuerzos en la lectura de cada texto por separado en detrimento de su capacidad cognitiva para comparar e integrar la información de las diferentes fuentes. Sin embargo, los estudiantes con problemas de lectura en niveles superiores de enseñanza han mostrado ser capaces de beneficiarse de la lectura de documentos múltiples a pesar de sus limitaciones (Strømsø et al., 2003). Strømsø et al. explican que estos estudiantes parecen compensar sus dificultades empleando estrategias complejas y activando su conocimiento previo sobre el tema de estudio.

Llegados a este punto, parece lógico preguntarse si el entrenamiento en el manejo de las estrategias que han sido identificadas como facilitadoras del estudio con documentos múltiples resulta efectivo para promover la comprensión e integración de la información presentada en varios textos. Son varios los estudios que han abordado esta cuestión, y todos ellos concluyen que el entrenamiento específico en estas estrategias mejora la comprensión e integración de los estudiantes.

Por ejemplo, Britt y Aglinskas (2002) desarrollaron un tutor informático de aplicación individual, i.e. *Sourcer's Apprentice*, para enseñar a los estudiantes a emplear las estrategias de evaluación de la información de la fuentes y corroboración descritas por Wineburg (1991). El programa presentaba a los estudiantes fuentes primarias y secundarias sobre un tema historia en una especie de biblioteca virtual. Los estudiantes leían los diferentes textos, al mismo tiempo que rellenaban una fichas acerca de las características de la fuente de cada uno de los textos (i.e. autor, año de publicación, tipo de documento y su contenido). Finalmente, los estudiantes escribían un ensayo acerca de la controversia histórica que describían los textos. Durante la escritura del ensayo los estudiantes disponían de las fichas que ellos mismos habían elaborado, pero no podían consultar los textos. Los estudiantes que fueron entrenados con el *Source's Apprentice* elaboraron ensayos que mostraban un mayor grado de integración de información que aquellos que no fueron entrenados y leyeron un único texto que contenía la misma información.

Otros estudios realizados al respecto, han puesto a prueba programas de entrenamiento en estrategias con documentos múltiples diseñados para ser trabajados en el aula ordinaria. VanSledright (2002) enseñó a estudiantes con edades comprendidas entre 10 y 12 años a estudiar con fuentes primarias y secundarias sobre un tema de historia e invitándoles a que se convirtieran en "detectives de acontecimientos históricos". Les explicaron cómo estos detectives realizan su trabajo identificando la naturaleza de las fuentes y las perspectivas que adoptan los autores

en los diferentes textos. También les enseñaron a comprobar y corroborar sus pruebas antes de sacar cualquier conclusión. Los resultados indicaron que los estudiantes eran capaces de beneficiarse de estudiar con varios textos, pero sólo si habían sido entrenados para ello.

Otro ejemplo de entrenamiento en el aula se expone en el estudio de Goldman y Bloome (2004), donde los alumnos recibieron instrucción explícita acerca de cómo emplear las estrategias de corroboración y atención a las fuentes en un tarea argumentativa con textos literarios. Así, enseñaban a los estudiantes a comparar la información de los diferentes textos, localizando las semejanzas y similitudes en el contenido de los mismos. Los resultados del estudio mostraron que los estudiantes también se beneficiaron de este programa de entrenamiento.

De acuerdo con los resultados de estos estudios, el dominio de las estrategias que facilitan el empleo de documentos múltiples es una variable que parece tener una relevancia clara en la comprensión e integración del material textual. Otra variable con influencia notable en los procesos de comprensión e integración de información es la tarea que enmarca la actividad de lectura en la que están envueltos los estudiantes.

1.4. TAREAS DE INTEGRACIÓN DE INFORMACIÓN CON DOCUMENTOS MÚLTIPLES

Cuando los estudiantes se enfrentan al estudio con documentos múltiples, los diferentes objetivos que pueden acompañar a la tarea de lectura cobran una especial importancia para determinar la naturaleza y la organización de los procesos mentales y estrategias que el lector ha de poner en marcha para alcanzar sus objetivos. Por ejemplo, ante un mismo conjunto de documentos relacionados, las estrategias de las que se sirve un lector para resolver una tarea cerrada (p.ej. responder a una pregunta concreta) no son las mismas que aquéllas que emplea otro lector cuyo propósito es resolver una tarea abierta (p.ej. escribir una síntesis personal sobre la información presentada en los documentos).

Aunque los resultados de las investigaciones que se han realizado al respecto son hasta el momento muy limitados, algunos estudios han mostrado que los estudiantes adaptan el modo en que procesan los textos a las demandas de la tarea de lectura. Por ejemplo, Strømsø et al. (2003) encontraron que los estudiantes de derecho ajustaban el procesamiento que hacían de una serie de textos en función de si el objetivo de la lectura era prepararse para un examen o el objetivo era prepararse para seguir una conferencia. Cerdán y Vidal-Abarca (2008) también observaron que los estudiantes variaban el modo en que procesaban los textos en función de las demandas de la tarea a la que habían sido expuestos. Los estudiantes que leyeron cuatro textos expositivos sobre resistencia bacteriana con el objetivo de responder a preguntas muy específicas se concentraban en la lectura de piezas aisladas de información y no mostraron ningún esfuerzo por integrar la información de los textos. Sin embargo, aquellos estudiantes que leyeron los mismos textos con el propósito de responder a preguntas más globales realizaban saltos en su proceso de lectura que iban desde un pieza de información pertinente para responder a la pregunta a otras piezas de información también pertinente pero localizadas en otro texto, lo que fue interpretado por los autores como un esfuerzo por integrar la información de los documentos.

Los resultados de éstas y otras investigaciones muestran que las condiciones de tarea afectan al modo de procesamiento y, en consecuencia, también afectan al nivel de comprensión del contenido textual que alcanzan los estudiantes. En este sentido, son varios los estudios realizados sobre la compresión de un texto único que muestran que las condiciones de tarea que requieren un mayor esfuerzo por parte del lector, en contraste con aquellas menos exigentes, promueven una comprensión más profunda del contenido del texto (McNamara, Kintsch, Songer, y Kintsch, 1996; Mannes y Kintsch, 1987; McDaniel y Donnelly, 1996; Cerdán et al. en prensa). Cuando se dificulta la tarea del lector, se le impide asumir una modalidad de procesamiento

superficial y se le obliga a adoptar un nivel más profundo que resulta en una representación mental más integrada.

En la última década, algunos investigadores del área de los documentos múltiples se han interesado por determinar qué tareas de integración de información se muestran como mejores candidatas para promover una comprensión profunda de los textos (Britt y Sommer, 2004; Bråten y Strømsø, en prensa; Le Bigot y Rouet, 2007; Cerdán y Vidal-Abarca, 2008; Kobayashi, en prensa; Naumann, Wechsung, y Krems, en prensa; Schwarz, 2003; Wiley y Voss, 1999). En general, los resultados de estas investigaciones coinciden en afirmar que las condiciones de tarea que demandan que el estudiante elabore la información de los textos y se forme una opinión del contenido de los mismos son las que producen mejores resultados.

En esta tesis, nos hemos centrado en estudiar el efecto de dos de las tareas más comunes para aprender con documentos múltiples, los resúmenes y los ensayos argumentativos. Tradicionalmente ambas tareas han sido consideradas buenas herramientas para el estudio de textos únicos. Así, por un lado, existe un amplio conjunto de estudios que demuestran que la tarea de resumen promueve la compresión y el aprendizaje de los estudiantes (para una revisión general ver Bransford, Brown, y Cocking, 2000). Por otro lado, las tareas argumentativas también han recibido un considerable apoyo por parte de los investigadores del área (Hemmerich y Wiley, 2002; Voss y Wiley, 2001; Wiley, 2001). Los resultados muestran que las tareas argumentativas promueven que los estudiantes se esfuercen en transformar e integrar la información textual lo que resulta en que alcancen una comprensión más profunda.

Cuando se trabaja con documentos múltiples, un resumen implica que el estudiante debe: (a) seleccionar la información más importante para el tema que se le pide, distinguiéndola de aquella otra que, aunque esté relacionada, no es tan importante; (b) reconocer cuándo la información importante de un documento ya ha

sido leída previamente en otro documento o bien es nueva y complementa a la que se ha leído previamente; (c) estructurar y redactar la información encontrada de forma coherente. Sin embargo, las tareas argumentativas implican que los estudiantes deben sumar a los procesos asociados a la tarea de resumen el esfuerzo por crearse su propia opinión acerca del contenido de los documentos y ser capaces de apoyar su opinión con la información que han leído en los textos.

Existen pocos estudios que comparan directamente el efecto de ambas tareas sobre la comprensión e integración de documentos. Además los resultados de estos estudios son todavía poco concluyentes. Wiley y Voss (1999) realizaron dos estudios en los que pedían a los estudiantes que escribieran ensayos argumentativos, narraciones, resúmenes o una explicación global acerca de la historia de Irlanda basándose en la información presentada en varios documentos o a modo de capítulo de libro. En ambos estudios, los estudiantes que escribieron el ensayo argumentativo, alcanzaron un aprendizaje más profundo e integrado que los estudiantes pertenecientes a las otras tres condiciones de tarea. También Le Bigot y Rouet (2007) obtuvieron resultados a favor de las tareas argumentativas. Pidieron a los estudiantes que participaron en su estudio que escribieran un ensayo argumentativo o un resumen después de leer un conjunto de documentos acerca de la influencia social. Los estudiantes que escribieron el ensayo argumentativo realizaron composiciones escritas más transformadas que los estudiantes que realizaron el resumen.

Sin embargo, otros resultados no han encontrado diferencias significativas en la comprensión que alcanzan los estudiantes bajo las condiciones de ambas tareas. Por ejemplo, Le Bigot y Rouet (2007) no encontraron diferencias en un cuestionario de comprensión acerca del contenido de los textos. Tampoco Bråten y Strømsø (en prensa) encontraron diferencias en la comprensión de los estudiantes que leyeron siete documentos acerca del cambio climático con la instrucción de elaborar un

resumen y aquellos que lo hicieron con la instrucción de elaborar un ensayo argumentativo

1.5. FACTORES QUE PUEDEN INTERACTUAR CON LAS TAREAS DE INTEGRACIÓN DE INFORMACIÓN.

Como ya hemos indicado, el cuerpo experimental de este trabajo ha sido inspirado por el enfoque de la triple interacción *contexto-texto-lector* propuesto por Rouet (2006) y Snow (2002). Por ello, además de interesarnos por estudiar cómo las variables de tarea intervienen en los procesos de comprensión e integración, nos interesamos por cómo éstas interaccionan con algunas de las variables cognitivas del lector y por cómo lo hacen con algunas de las variables que caracterizan al material textual. Dos son las variables del lector que estudiaremos y que a priori consideramos que pueden moderar el efecto de la tarea en la compresión e integración de la información: las creencias epistemológicas y el nivel de conocimiento previo. Respecto a las variables que caracterizan al material textual nos centraremos en el modo en que es presentada la información (información impresa vs. información digitalizada) y la cantidad de información que los estudiantes deben leer e integrar.

Las creencias epistemológicas

Las creencias epistemológicas hacen referencia a las concepciones o pensamientos que las personas sostienen acerca de la naturaleza del conocimiento y el proceso de conocer (Hofer y Pintrich, 1997). Los últimos estudios rechazan la idea de que las creencias epistemológicas formen un constructo unidimensional y las describen formando parte de un sistema de dimensiones más o menos independientes (Schommer, 1990; Hofer y Pintrich, 1997). Desde esta perspectiva, uno de los enfoques teóricos más apoyados y al que nos acogemos en esta tesis es el formulado por Hofer y Pintrich (1997). Proponen un sistema de creencias formado por dos dimensiones relativas a la naturaleza del conocimiento (qué es el conocimiento):

C*erteza del conocimiento* y S*implicidad del conocimiento* y dos dimensiones relativas al proceso de conocer (cómo se construye el conocimiento): *Fuente de conocimiento* y *Justificación del conocimiento*. La dimensión Certeza del conocimiento hace referencia al grado en que los estudiantes consideran el conocimiento tentativo y en constante evolución en lugar de estable y verdadero. La dimensión Simplicidad define el grado en que los estudiantes consideran que el conocimiento se estructura como un conjunto de conceptos interrelacionados y teorías complejas y no como una acumulación de hechos aislados e inconexos. La dimensión Fuente de conocimiento evalúa hasta qué punto los estudiantes se consideran a sí mismos como una fuente de conocimiento válida y no creen que el conocimiento debe ser transmitido y elaborado únicamente por los expertos. Finalmente, la dimensión Justificación del conocimiento hace referencia a las creencias que tienen los estudiantes acerca de que el conocimiento debe justificarse y contrastarse , mediante el empleo de estrategias de razonamiento y la evaluación crítica de fuentes diversas en contraposición a las creencias de que debe construirse atendiendo a aquello que cada uno siente o percibe que es correcto.

En los últimos años, se han realizado un gran número de investigaciones con estudiantes de secundaria y estudiantes universitarios que muestran los efectos de las creencias epistemológicas sobre aspectos como la motivación hacia los estudios, el funcionamiento de los procesos cognitivos, el desarrollo intelectual o el rendimiento académico (ver Bråten, en prensa). Recientemente, se han realizado estudios que relacionan las creencias epistemológicas con la comprensión de documentos múltiples. En general, los resultados de estos estudios muestran que las creencias menos sofisticadas (p.ej. *el conocimiento es estable y verdadero*) se asocian a una comprensión e integración más pobre de la información textual. Por ejemplo, Rukavina y Daneman (1996) encontraron que los estudiantes que consideraban que el conocimiento se estructura como una acumulación de hechos aislados e inconexos tenían problemas para integrar la información presentada en dos documentos acerca

de teorías científicas. Asimismo, Bråten y Strømsø (2006a) encontraron que sólo los estudiantes con creencias epistemológicas más sofisticadas eran capaces de beneficiarse del estudio con documentos múltiples.

En esta tesis contribuiremos al conocimiento existente acerca del papel de las creencias epistemológicas en la comprensión e integración de documentos múltiples, analizando el efecto de interacción de esta variable con la tarea de lectura. Poco sabemos hasta la fecha sobre la naturaleza de esta interacción. Únicamente Bråten y Strømsø (en prensa), en una investigación relacionada con los estudios que se presentan en esta tesis, han abordado esta cuestión. En su estudio encontraron que los efectos de la tarea en la comprensión e integración de información de siete textos acerca del cambio climático dependían del grado de sofisticación de las creencias de los estudiantes. Aquellos estudiantes con creencias epistemológicas más sofisticadas en la dimensión de certeza del conocimiento, caracterizados por considerar el conocimiento tentativo y en constante evolución se beneficiaban más de las tareas argumentativas que los estudiantes con creencias más ingenuas, caracterizados por considerar el conocimiento estable y verdadero.

El conocimiento previo

Son varios los estudios que muestran que el conocimiento previo de los estudiantes acerca del tema de estudio parece tener una papel fundamental en los procesos de comprensión e integración de información (p.ej. Bråten et al., in press; Moos y Azevedo, 2008; Pieschl, Stahl, y Bromme, 2008; Strømsø, Bråten, y Britt, 2008; Wineburg, 1991). En esta tesis estudiamos la posibilidad de que diferentes tareas de integración de información demanden diferentes niveles de conocimiento previo.

La investigación en comprensión de un texto único ha mostrado que los efectos de la tarea de lectura en el aprendizaje de los estudiantes pueden variar atendiendo al

conocimiento previo que éstos manifiestan. Por ejemplo, McNamara et al. (1996) examinaron los efectos de las condiciones de tarea (textos con alta cohesión vs. textos con baja cohesión) y el conocimiento previo en la comprensión lograda por estudiantes de secundaria de un texto científico sobre enfermedades cardíacas. Se descubrió que la condición de aprendizaje que incluía un texto de alta cohesión beneficiaba la comprensión de los lectores de bajo nivel de conocimiento. Los lectores con bajo nivel de conocimiento no podían llenar con facilidad los vacíos en los textos de baja cohesión, porque carecían del conocimiento para generar las inferencias necesarias. En consecuencia, requerían textos de alta cohesión para comprender y recordar el contenido de los mismos. Por el contrario, los lectores que tenían un alto nivel de conocimiento se beneficiaban con el texto de baja cohesión. El texto menos cohesivo obligaba al lector a llenar los vacíos en el texto, usando inferencias basadas en el conocimiento lo que promovía una comprensión más profunda de la situación descrita en el texto.

Sin embargo, la investigación con textos múltiples apenas ha abordado esta cuestión. Sólo Le Bigot y Rouet (2007) han estudiado directamente la relación entre el conocimiento previo de los estudiantes y las condiciones de tarea en el área de los documentos múltiples. En su estudio no encontraron ningún efecto de interacción entre el conocimiento previo de los estudiantes (alto *vs.* bajo) y la tarea (argumentación *vs*. resumen), lo que pudo ser debido las escasas diferencias en el nivel de conocimiento previo entre sus estudiantes.

Modo de presentación de la información

Otro variable estudiada en uno de los estudios que se presentan en esta tesis es el modo de presentación de la información. En este caso, también estamos interesados en observar si el efecto de la tarea es dependiente del modo en que los estudiantes leen los textos. Concretamente estudiaremos las diferencias que se producen en la comprensión e integración de información cuando la información es

presentada a los estudiantes en papel o en una pantalla de ordenador. En uno de nuestros estudios, la mitad de los estudiantes leyó los textos en papel, mientras que la otra mitad los leyó en la pantalla de un ordenador haciendo uso del software *Read&Answer* (Martínez y Sellés, 2000).

Son varios los estudios que han mostrado diferencias entre la lectura digital y la lectura en texto impreso. Por ejemplo, Murphy, Long, Holleran, and Esterly (2003) encontraron que los estudiantes que leyeron dos textos en la pantalla de un ordenador, encontraron los textos más difíciles de comprender y menos interesantes que aquellos que los leyeron en papel. Los autores ofrecen dos explicaciones alternativas a sus resultados. Por un lado argumentan que es posible que los estudiantes se encontraran con problemas al transferir sus estrategias de comprensión al proceso de comprensión de textos digitalizados, o que alternativamente, las estrategias que requiere la lectura digital no son exactamente las mismas que las requeridas por los textos impresos. Por otro lado, autores como Landauer (1996) o Nielsen (2002) sostienen que la lectura digital es perceptualmente más difícil y lenta que la lectura en texto impreso.

Sin embargo, existen también algunos estudios (McKnight, Dillon, y Richardson, 1990; Muter y Maurutto, 1991) que concluyen que la lectura en texto escrito y la lectura digitalizada no produce diferencias en la comprensión y velocidad de lectura de los estudiantes.

Tras esta breve exposición del marco teórico de la investigación, pasamos a presentar el trabajo experimental realizado en los siguientes capítulos. La organización de los mismos se corresponde básicamente con el planteamiento de los objetivos. Así, el capítulo 2 analiza la estructura de las creencias epistemológicas de estudiantes universitarios. En el capítulo 3 se examina el efecto de interacción de las creencias epistemológicas con el tipo de tarea que realizan los estudiantes durante la lectura de documentos múltiples. El capítulo 4 analiza la interacción entre el tipo de tarea, el

conocimiento previo y el tipo de presentación de la información. Finalmente, en el capítulo 5 se presentan las principales conclusiones alcanzadas en los estudios.

CAPÍTULO 2

Personal Epistemology across Cultures: Exploring Norwegian and Spanish University Students' Epistemic Beliefs about Climate Change

ABSTRACT

The primary aim was to explore and compare the dimensionality of personal epistemology with respect to climate change across the contexts of Norwegian and Spanish students. A second aim was to examine relationships between topic-specific epistemic beliefs and the variables of gender, topic knowledge, and topic interest in the two contexts. Participants were 225 Norwegian and 217 Spanish undergraduates enrolled in psychology or education courses, and the dimensionality of topic-specific personal epistemology was explored through factor analyses of the scores on a 49-item questionnaire. Hierarchical multiple regression analyses were used to predict scores on the epistemic belief dimensions emerging from the factor analyses with gender, topic knowledge, and topic interest, respectively. Even though considerable cross-cultural generalizability in dimensionality was demonstrated, this research also draws attention to the cultural embeddedness of topic-specific epistemic beliefs. Moreover, differences in the predictability of topic knowledge and topic interest in Norway and Spain, suggest that factors constraining or enhancing adaptive epistemic beliefs concerning particular topics may vary across cultures.

INTRODUCTION

The main aim of this study was to explore and compare the dimensionality of personal epistemology with respect to a particular scientific topic across the educational and cultural contexts of Norwegian and Spanish university students. Additionally, we wanted to explore the extent to which relationships between topic-specific epistemic beliefs and other relevant variables, specifically, gender, topic knowledge, and topic interest, were similar or different across the two contexts.

In the last decades, educational psychologists have become increasingly interested in the conceptions of knowledge and knowing that students hold, with the term personal epistemology coined to distinguish the lay person's view about knowledge and knowing from the trained philosopher's view (Hofer & Pintrich, 2002). Thus, the term personal epistemology essentially refers to the beliefs or theories that students (and other individuals) hold about knowledge and the process of knowing (Hofer & Pintrich, 1997, 2002), that is, epistemic beliefs (Kitchener, 2002). Currently, there is abundant evidence demonstrating the important role played by personal epistemology in students' academic motivation, cognition, and performance (for review, see Bråten, in press).

While much important work on personal epistemology has continued Perry's (1970) early effort to identify developmental stages or sequences in students' epistemic thinking, mostly by conducting in-depth interviews (e.g., Baxter Magolda, 1992; King & Kitchener, 1994; Kuhn, 1991), Schommer (1990) departed from the developmental paradigmatic approach (cf., Hofer, 2004a) and introduced quantitative assessment in the form of a 63-item domain-general questionnaire allowing for group administration and statistical analyses of student scores. Schommer (1990) theoretically assumed that

personal epistemology consisted of more or less independent beliefs about the certainty, simplicity, and source of knowledge, as well as beliefs concerning the speed of learning and the fixity of ability. Consequentially, she created two or three subsets of items to assess each of the five proposed dimensions and used the resulting 12 subsets of the 63 items as variables in factor analyses to empirically explore the dimensionality of personal epistemology. Those factor analyses (e.g., Schommer, 1990, 1993; Schommer, Calvert, Gariglietti, & Bajaj, 1997; Schommer, Crouse, & Rhodes, 1992) consistently yielded four factors, which, stated from a naïve perspective, were: *certain knowledge* (ranging from the belief that knowledge is absolute and unchanging to the belief that knowledge is tentative and evolving), *simple knowledge* (ranging from the belief that knowledge is best characterized as isolated bits and pieces to the belief that knowledge is best characterized as highly interrelated concepts), *quick learning* (ranging from the belief that learning takes place quickly or not at all to the belief that learning is gradual), and *fixed ability* (ranging from the belief that ability to learn is given at birth to the belief that ability to learn can be increased). Thus, source of knowledge, which Schommer (1990) suggested would range from the belief that knowledge is handed down by authority to the belief that knowledge is derived from reason, was the only hypothesized dimension that did not emerge as a factor from those analyses.

However, with the use of common factor-analytic methodology, that is, individually factoring items rather than *a priori* subsets, the Schommer Epistemological Questionnaire (SEQ) has sometimes resulted in another dimensionality of personal epistemology than that reported by Schommer and associates. (In fact, this has also happened with factoring based on subsets of items; e.g., Kardash & Howell, 2000.) For example, when Qian and Alverman (1995) conducted an item-based factor analysis of SEQ-scores after eliminating items related to the hypothesized dimension concerning source of knowledge, which had not emerged as a factor in prior research, certainty

and simplicity of knowledge merged to one factor, appearing together with quick learning and fixed ability. Somewhat later, Hofer (2000) reported that an item-based factor analysis of the 32 items of the SEQ that fell on Qian and Alverman's three factors yielded a four-factor solution where no single factor replicated the factors reported by Schommer. Nor did Hofer (2000) find the certainty/simplicity factor identified by Qian and Alverman. When Schraw, Bendixen, and Dunkle (2002) individually factored all 63 items of the SEQ, they obtained a five-factor solution including only 11 items, where two factors (certain knowledge 1 and fixed ability) corresponded to factors reported by Schommer, and three other factors (incremental learning, certain knowledge 2, and integrative thinking) differed from her results. Notably, Schraw et al. identified two certainty factors representing different constructs. Whereas certain knowledge 1 concerned the likelihood that scientists will ultimately discover universal truths and, thus, represented the construct of "accessibility to certain knowledge", certain knowledge 2 concerned the degree to which certain knowledge exists and, thus, represented the construct of "likelihood of certain knowledge" (Schraw et al., 2002, p. 266).

In addition to factor analyses of students' SEQ-scores, scores on other domain-general personal epistemology questionnaires have been factor analyzed. For example, Jehng, Johnson, and Anderson (1993) reported that factor analysis of scores from a 51-item domain-general questionnaire, with 29 of the items taken from the SEQ, yielded five factors representing certainty of knowledge, source of knowledge, orderly learning, quick learning, and fixed ability, respectively. When Wood and Kardash (2002) analyzed scores on 58 items from the SEQ together with the 22 items that were unique to Jehng et al.'s (1993) questionnaire, they identified factors similar to simple knowledge, quick learning, and fixed ability in Schommer's scheme, as well as a factor corresponding to certain knowledge 2 (i.e., likelihood of certain knowledge) as identified by Schraw et al. (2002). In addition, Wood and Kardash identified a factor

that was labelled “knowledge construction and modification”, with high scores on this factor representing the view that knowledge is constantly evolving, is actively and personally constructed, and should be subject to questioning, and low scores representing the view that knowledge is certain, passively received, and accepted at face value. This last-mentioned factor bears some resemblance to orderly learning as identified by Jehng et al. (1993), as well as to a combination of incremental learning and integrative thinking as identified by Schraw et al. (2002). Finally, it should be mentioned that Schraw et al. (2002) succeeded in identifying all the five dimensions in Schommer’s (1990) original conceptualization (i.e., certain knowledge, simple knowledge, source of knowledge, quick learning, and fixed ability) by individually factoring 28 items from a domain-general questionnaire constructed to assess the same dimensions in a more unambiguous and efficient way. Taken together, however, research on the dimensionality of domain-general personal epistemology has produced somewhat inconsistent findings (see also, DeBacker, Crowson, Beesley, Thoma, & Hestevold, 2008). One reason may be that students who respond to items written to assess general beliefs (e.g., “The only thing that is certain is uncertainty itself”), may keep quite different domains and topics in mind while responding, and this, in turn, may lead to differences not only in levels but also in dimensionality of scores. Given this possibility, we turn to a brief review of research on the dimensionality of domain-specific personal epistemology.

The issue of domain-generality versus domain-specificity has been much debated in recent years (for reviews, see Buehl & Alexander, 2001; Muis, Bendixen, & Haerle, 2006). What researchers in personal epistemology mean by “domain” seems to vary somewhat (Hofer, 2006; Limon, 2006). However, most of them use it synonymously with discipline (Hofer, 2006; Muis et al., 2006). In accordance with this, we equate the term domain as comparable to discipline or academic domain in this article. When Muis et al. (2006) thoroughly reviewed the generality—specificity

personal epistemology research conducted so far, they concluded that this is not really an issue of either—or. Rather, students hold both domain-general and domain-specific epistemic beliefs. This conclusion was also supported by a recent empirical study by Buehl and Alexander (2005), using cluster analysis to compare the student profiles that emerged from different dimensions of personal epistemology across the domains of mathematics and history. While the distinct epistemic belief profiles that emerged differed across the two domains, there was also some consistency in students' profile membership in mathematics and history, with this finding also in accordance with a dual-level conception of personal epistemology.

In a first investigation of the dimensionality domain-specific personal epistemology, Hofer (2000) built on a theoretical framework for personal epistemology proposed by Hofer and Pintrich (1997). Hofer and Pintrich (1997) reviewed the existing literature on personal epistemology and argued convincingly that beliefs concerning learning (e.g., quick learning) and intelligence (e.g., fixed ability) should not reside within the boundaries of this construct. Instead, they proposed that personal epistemology exclusively consists of two dimensions concerning the nature of knowledge (what one believes knowledge is) and two dimensions concerning the nature or process of knowing (how one comes to know). Within the area of nature of knowledge, the hypothesized dimensions *certainty of knowledge* and *simplicity of knowledge* correspond to certain knowledge and simple knowledge as described by Schommer (1990). Within the area of nature of knowing, the dimension *source of knowledge* was hypothesized to range from the conception that knowledge originates outside the self and resides in external authority, from which it may be transmitted, to the conception that knowledge is actively constructed by the person in interaction with others. At least in part, this dimension parallels the source dimension as described by Schommer (1990). The final dimension in the Hofer and Pintrich (1997) conceptualization, *justification for knowing*, also concerns the nature of knowing, with

this dimension referring to how individuals justify and evaluate knowledge claims. This dimension, which seems to have no clear parallel within Schommer's (1990) belief system, was hypothesized to range from justification through observation and authority, or on the basis of what feels right, to the use of rules of inquiry and the evaluation and integration of multiple information sources.

Hofer (2000) devised a 27-item questionnaire to assess domain-specific epistemic beliefs, the Discipline-Focused Epistemological Beliefs Questionnaire (DFEBQ), and conducted exploratory factor analyses of item scores to empirically test the existence and representation of the four dimensions proposed by Hofer and Pintrich (1997). On the DFEBQ, each item referred to a particular field or subject matter as a frame of reference (e.g., "In this field, knowledge is certain"), and the students were asked to keep either psychology or science in mind as they responded to the items. Hofer (2000) identified four factors underlying the DFEBQ-scores regardless of whether the domain was psychology or science. First, Hofer identified a certain/simple knowledge factor similar to the one reported by Qian and Alverman (1995) with a domain-general questionnaire. Second, two factors representing source of knowledge and justification for knowing, respectively, emerged, even though those factors did not represent the full breadth of the hypothesized dimensions. Third, an unhypothesized factor labelled "attainability of truth" emerged, with this factor corresponding to "likelihood of certain knowledge" as identified by Schraw et al. (2002) and by Wood and Kardash (2002) with the use of domain-general measures.

Buehl, Alexander, and Murphy (2002) developed a questionnaire more specifically devised to assess domain-specific epistemic beliefs, the Domain-Specific Beliefs Questionnaire (DSBQ), with this instrument containing items focusing on either mathematics (e.g., "There are links between mathematics and other disciplines") or history ("There are links between history and other disciplines"). It should be noted that Buehl et al. (2002) originally wrote domain-specific items to capture the four

dimensions identified by Schommer and associates with the SEQ (i.e., certain knowledge, simple knowledge, quick learning, and fixed ability) rather than the four dimensions included in the Hofer and Pintrich (1997) conceptualization. Using confirmatory factor analysis after first having explored the factor structure of a preliminary version of the DSBQ, and also after having eliminated items written to assess quick learning and fixed ability, respectively, Buehl et al. (2002) identified two corresponding epistemic belief dimensions in mathematics and history. Thus, in each domain a factor labelled “need for effort” was identified, with items included in this factor focusing on the extent to which students believed knowledge acquisition in mathematics and history, respectively, required time and effort. Additionally, a factor labelled “integration of information and problem solving” was identified in each domain, with items representing this factor focusing on the degree to which students believed knowledge in mathematics and history, respectively, to be integrated with knowledge in other areas in and out of school.

Some time later, Buehl and Alexander (2004) created a domain-specific personal epistemology measure by selecting items pertaining to beliefs about the certainty of knowledge and beliefs about authority as the source of knowledge from the DFEBQ (Hofer, 2000) and items addressing beliefs about the isolation of knowledge from the DSBQ (Buehl et al., 2002). Each item specified that it concerned either history or mathematics (e.g., “Principles in history/mathematics are unchanging”). Buehl and Alexander (2004) reported that confirmatory factor analysis of the scores on the resulting measure yielded three corresponding factors in each domain, concerning beliefs about the certainty, simplicity, and source of knowledge, respectively (see also, Buehl & Alexander, 2005).

At this point, it should be acknowledged that just as research on the dimensionality of domain-general personal epistemology has produced somewhat inconsistent findings, so has research on the dimensionality of domain-specific

epistemic beliefs. One likely reason for this is that investigations of domain-specific beliefs have also used different measures that, at least in part, are based on different conceptualizations of personal epistemology. Moreover, the fact that investigations of dimensionality in domain-general and domain-specific personal epistemology have used measures differing not only in terms of generality versus specificity but also in terms of theoretical framework, makes it difficult to judge how consistent corresponding factors appear across the two levels. Still, it should be noted that within each of the domain-specific investigations reviewed above, there was consistency in the dimensions that emerged across domains, with this suggesting that a set of more general epistemic beliefs might underlie beliefs specific to each domain (Buehl & Alexander, 2004).

While most of the domain-general research on the dimensionality of personal epistemology was based on Schommer's (1990) conceptualization, current domain-specific research seems to be more inspired by Hofer and Pintrich's (1997) theoretical framework. However, being definitely the most influential framework for thinking about the dimensionality of personal epistemology in current educational psychology, the Hofer and Pintrich (1997) conceptualization could be said to suffer from an empirical deficit. At least, Hofer and Pintrich's (1997) conceptually derived dimensions have so far not been unequivocally empirically verified through factor analysis of questionnaire data (cf., Buehl, 2008). Still, use of qualitative methodologies such as observations and interviews (Hofer 2004b) or think-aloud protocols (Hofer, 2004c) suggests that all the four dimensions proposed by Hofer and Pintrich (1997) are represented in students' epistemic thinking. In the present study, however, we took a different tack and explored whether the dimensions proposed by Hofer and Pintrich could be identified at a topic-specific level of personal epistemology.

While the conclusion that personal epistemology includes levels of both domain generality and domain specificity has gained support in the literature (Buehl &

Alexander, 2001; Muis et al., 2006), a potentially useful distinction between domain-specific and topic-specific epistemic beliefs has received less attention. However, just as domain knowledge and topic knowledge may form subcategories of formally acquired or schooled knowledge, with domain knowledge referring to the breadth of one's knowledge about a domain (e.g., psychology or history), and topic knowledge representing the depth of one's knowledge about particular topics within a domain (e.g., motivation or World War II) (Alexander, Schallert, & Hare, 1991), beliefs about knowledge and knowing in a domain may be distinguished from epistemic beliefs about topics within domains (Bråten, in press). It should be noted that while the term "topic" may, indeed, have several meanings, we use it in this article to refer to a more delimited subject area that can be subsumed under a discipline or academic domain. As an example of research on the topic-specific level of personal epistemology, Trautwein and Lüdtke (2007) recently used questionnaire items to examine students' epistemic beliefs about specific scientific theories, for example, about biological theories concerning natural selection and extinction of the dinosaurs, respectively. In that study, it was found that epistemic beliefs differed considerably across theories. Also, Stahl, Bromme, and their colleagues (Kienhues, Bromme, & Stahl, in press; Pieschl, Stahl, & Bromme, 2008; Stahl & Bromme, 2007) have started to focus on topic-specific personal epistemology. However, none of their efforts to examine the dimensionality in topic-specific personal epistemology through factor analysis, neither when using a semantic differential measure nor when using a topic-specific version of Hofer's (2000) DFEBQ, have resulted in the four dimensions described by Hofer and Pintrich (1997). To further address this issue, we tried to construct a measure where each item fit into one of Hofer and Pintrich's (1997) four proposed dimensions, at the same time referring to beliefs concerning knowledge and knowing about a specific scientific topic—climate change. When responding to domain-specific items concerning knowledge and knowing, students may actually consider different topics within a

domain. For example, while some students responding to items concerning the domain of history may reflect on World War II (1939-1945), others may reflect on the Persian wars (490 B.C. and 480-479 B.C.). Because students may hold different knowledge beliefs about the two topics (e.g., that knowledge about World War II is more certain than is knowledge about the Persian wars), a potential source of variance is eliminated when examining the dimensionality of topic-specific personal epistemology. Moreover, examining personal epistemology on a topic-specific level accords with a more general emphasis on contextual factors in research on academic learning and motivation (e.g., Bandura, 1997; Bransford, Brown, & Cocking, 2000), and it involves a further contextualization in comparison with a focus on domain-specific beliefs. For example, by focusing on topic-specificity, research on personal epistemology is brought closer to the level of specificity focused in research on another set of powerful student beliefs, self-efficacy beliefs, which concern student beliefs about their capability to perform specific tasks (cf., Pajares, 1996). Thus, there seem to be several reasons to extend research on the dimensionality of personal epistemology to include a topic-specific level.

In addition to addressing a topic-specific level of personal epistemology, we wanted to directly compare the dimensionality of epistemology across cultures in the present study. A decade ago, Hofer and Pintrich (1997) noted the paucity of cross-cultural research on epistemic beliefs, stating that “existing frameworks based on US samples are undoubtedly shaped by underlying cultural beliefs” (p. 130). In regard to the dimensionality issue, in particular, Schommer-Aikins (2002) emphasized the need to study the dimensionality of personal epistemology across cultures, suggesting that different factor structures might reflect cultural differences. In fact, several factor-analytic studies using Schommer’s (1990) domain-general questionnaire or another domain-general instrument based on this, conducted in Asian (e.g., Chan & Elliot, 2002; Youn, Yang, & Chori, 2001) as well as in European (e.g., Bråten & Strømsø,

2005; Clarebout & Elen, 2001; Clarebout, Elen, Luyten, & Bamps, 2001; Rozendaal, de Brabander, & Minnaert, 2001) countries, have resulted in factor structures differing from that reported by Schommer and associates (for review, see Buehl, 2008). However, an issue with these studies is that they are limited to the use of domain-general measures, mostly based on the Schommer (1990) conceptualization (see, however, Karabenick & Moosa, 2005). Moreover, only a couple of previous studies (Karabenick & Moosa, 2005; Youn, 2000) directly compared the dimensionality of personal epistemology across cultures. Given such limitations, the current research extended previous cross-cultural work on the dimensionality of personal epistemology in at least two ways. First, we based our topic-specific measure on the theoretical framework that Hofer and Pintrich (1997) developed after an extensive review of research conducted with US student samples. Second, we explored the cross-cultural generalizability of this influential framework by directly comparing the dimensionality of topic-specific personal epistemology across samples of Norwegian and Spanish undergraduate university students. By measuring personal epistemology on a topic-specific level, we tried to ensure that participants in the two contexts did not have different domains or different topics within domains in mind while responding to questionnaire items.

Finally, we wanted to explore relations among topic-specific epistemic beliefs and gender, topic knowledge, and topic interest, respectively, in each cultural context. So far, findings regarding gender differences in personal epistemology have been inconsistent and, therefore, this issue merits further study. Whereas some studies (e.g., Enman & Lupart, 2000; Hofer, 2000; Schommer, 1993; Schommer & Dunnell, 1994; Wood & Kardash, 2002) have found gender differences on only some dimensions, others (e.g., Buehl et al., 2002; Study III) have demonstrated a general lack of gender differences. According to Buehl et al. (2002), gender differences may be more pronounced when considered without regard to specific domains of knowledge,

because when responding to items concerning knowledge and knowing in general, males and females may well reflect on different types of knowledge or domains. By examining domain-specific or even topic-specific personal epistemology, however, this source of variance is removed, making it less likely that any gender differences appear. Moreover, it should be noted that gender differences, in the favour of females, have most consistently been found on the dimensions quick learning and fixed ability, respectively. The fact that those dimensions were not included in the framework on which we based our instrument, made it even less likely that any gender differences would be present in this study.

In previous studies, educational level (e.g., Perry, 1970; Schommer et al., 1997; Wood & Kardash, 2002) and expertise (e.g., Alexander & Dochy, 1995; Kuhn, 1991) have been found to be associated with personal epistemology. Because knowledge as well as interest seem to be essential aspects of increasing competence and expertise in a domain (Alexander, 2004), we wanted to focus especially on the role of knowledge and interest in personal epistemology. At the same time, we wanted to measure both knowledge and interest at the same level of specificity as personal epistemology, that is, with particular reference to the topic of climate change. Presumably, students more knowledgeable about the topic would also be more likely to judge knowledge about climate change to be tentative and complex, as well as to be derived from multiple sources that would have to be compared and critically evaluated. Hence, more knowledgeable students would also display more sophisticated epistemic beliefs concerning knowledge and knowing in the area. However, with respect to topic interest, it seems possible to entertain two alternatives. First, one possibility is that students expressing higher personal interest in the topic would also be more likely to hold sophisticated beliefs about knowledge and knowing. Alternatively, another possibility is that students reporting higher levels of personal involvement and engagement in the topic, also more likely to attach values and feelings to it (Hidi, 2001; Renninger, 2000),

would be more prone to display some kind of one-sidedness or my-position bias with respect to epistemic beliefs. Consequentially, students high in topic interest could be more likely to hold more naïve topic-specific beliefs, for example, that there is only one correct answer to the issue of climate change, corresponding to their own position, and supported by experts in the area.

Given this theoretical background analysis, we set out to answer two questions in our investigation. First, does the US-based theoretical framework for personal epistemology set forth by Hofer and Pintrich (1997), including the dimensions of certainty of knowledge, simplicity of knowledge, source of knowledge, and justification for knowing, capture the dimensionality of topic-specific epistemic beliefs in Norwegian and Spanish university students? We expected that the four dimensions proposed by Hofer and Pintrich (1997) would be identified with the topic-specific measure that we used, but that there would also be some cultural variation in the dimensionality of epistemic beliefs concerning climate change. Some cultural variation was expected on the basis of previous, albeit domain-general, studies of the dimensionality of personal epistemology in different cultures, as well as the possibility that knowledge and knowing concerning climate change had been differently focused in both public debate and education in the northern and southern regions of Europe. Moreover, it could be argued that there is a strong anti-authoritarian strain in Norwegian culture, both in and out of school, which may manifest itself in an extensive skepticism to information stemming from agents of influence such as politicians, scientists, and the media (e.g., Barstad & Hellevik, 2004; EU, 2005). In contrast, Spanish culture seems to be characterized by stronger social conformity, at least among young people, with a tendency to uncritically accept information from authorities and the media (e.g., Digón, 2003; Ministerio de Trabajo y Asuntos Sociales, 2006). Taken together, such cultural differences between Norway and Spain made it highly relevant to compare Norwegian and Spanish students with respect to personal epistemology in this investigation. Given

the still exploratory nature of cross-cultural studies of personal epistemology (Maggioni, Riconscente, & Alexander, 2006), however, we did not have any specific hypotheses concerning how particular cultural traits would be related to dimensionality in personal epistemology. Also, because prior research on the dimensionality of topic-specific personal epistemology is essentially lacking, we considered it most appropriate to investigate the dimensionality of personal epistemology concerning a specific topic through exploratory rather than confirmatory factor analysis.

Second, to what extent are the variables of gender, topic knowledge, and topic interest, respectively, related to dimensions of personal epistemology? Based on previous research and theoretical assumptions referred to above, we did not expect any gender differences with respect to topic-specific epistemic beliefs in this study. However, in regard to topic knowledge, we expected that students more knowledgeable about the topic of climate change would also hold more sophisticated epistemic beliefs about the topic. Finally, the two possible results that we entertained with respect to topic interest and epistemic beliefs involved that higher interest in the topic of climate change could either be related to more sophisticated or to more naïve epistemic beliefs. Acknowledging the exploratory nature of this investigation of relationships among gender, topic knowledge, topic interest, and epistemic beliefs across cultures, we did not make any particular predictions regarding similarities and differences with respect to relationships among these variables in the two cultures.

2.1. METHOD

Participants and Settings

The participants were 441 university students. Approximately half of the participants were Norwegians attending the University of Oslo; the other half were Spanish students enrolled in the University of Valencia and the Catholic University of Valencia, respectively. The Norwegian and Spanish participants were at comparable

levels of postsecondary education, and all were enrolled in psychology or education courses.

Specifically, the Norwegian data were collected from 225 undergraduate students following an introductory course in educational science. The course was a mandatory course for students enrolled in three-year bachelor programs in education and special education, and it included the following four areas: philosophy of science and research methodology; learning and development; instruction, training, and Bildung[1]; and socialization and upbringing. Among the Norwegian participants, 81.3 % were female and 18.7 % were male, with an overall mean age of 22.9 (*SD* = 5.6). With very few exceptions, the students in this sample were white native-born Norwegians who had Norwegian as their first language and had completed their secondary education in a Norwegian school.

In Spain, 216 undergraduate students participated in the study. While 164 participants (139 from the University of Valencia and 35 from the Catholic University of Valencia) were following an introductory psychology course for students enrolled in a five-year program in psychology, 52 participants (from the University of Valencia) were enrolled in the introductory course of a three-year program for students pursuing a degree in preschool teaching. The last-mentioned course focused on preschool learning and development. The Spanish participants were 79.6 % female and 20.4 % male, with an overall mean age of 19.9 (*SD* = 4.9). Almost all the participants from Spain were white native-born Spaniards who had Spanish as their first language.

Materials

Topic knowledge measure. As a means of assessing students' prior knowledge about the topic of climate change, we developed a multiple-choice test composed of 17 items. The content of the items referred to concepts and information central to the issue of climate change, for example, the greenhouse effect, climate

gases, and the Kyoto Protocol. The topic knowledge measure are displayed in the Appendix A. It should be noted that diverse aspects of the issue were covered by the topic knowledge measure, with items referring to both scientific (e.g., the greenhouse effect) and political (e.g., the Kyoto Protocol) aspects of the topic. A preliminary version of the topic knowledge measure was reviewed by a climate researcher at the University of Oslo, with this resulting in only small modifications of the response alternatives of a couple of items.

We expected the participants' topic knowledge to vary substantially even though they had not formally studied the topic of climate change. Because climate change was discussed in newspapers and other media in both Norway and Spain, participants would have had good opportunity to acquire knowledge about the topic.

Participants' topic knowledge score was a composite of the number of correct responses out of the 17 items. In Norway, the test-retest reliability of the scores on the topic-knowledge measure was computed in an independent sample of first-year education undergraduates (n = 56), with two weeks between the test and the retest. This yielded a reliability estimate (Pearson's r) of .77. In Spain, the test-retest reliability was .73 after two weeks in an independent sample of first-year psychology undergraduates (n = 80).

Topic interest measure. To measure participants' personal interest and engagement in issues and activities concerning climate change, we developed a 12-item measure, where participants indicated their level of interest or engagement by rating each item on a 10-point Likert-type scale ranging from *not at all true of me* (1) to *very true of me* (10). Half of the items allowed participants to express their interest in the topic without obligation, that is, without reporting any active engagement or involvement in addressing the problem of climate change (sample items: I am interested in what conditions influence the Earth's climate; Global warming is an issue that interests me). However, the other half of the items focused more on participants'

active engagement and involvement in the issue, thus reflecting their willingness to act for the benefit of the Earth's climate (sample items: I am concerned with how I myself can contribute to the reduction of environmental pollution; I try to convince others that we must reduce the discharges of climate gases), see Appendix B.

To explore the underlying structure of this measure, the Norwegian and the Spanish data from the 12 interest items were separately submitted to a principal component analysis, using oblique rotation because we thought that potential components might be correlated. However, in both data sets, all the 12 items loaded on only one factor, with this indicating that topic interest as assessed by this measure was a unidimensional construct. Hence, we used a sum score based on all the 12 items to gauge participants' interest in the topic of climate change. In both Norway and Spain, scores on the topic interest measure yielded a reliability estimate (Cronbach's α) of .91.

Personal epistemology measure. To assess participants' personal epistemology concerning climate change, we designed the Topic-Specific Epistemic Beliefs Questionnaire (TSEBQ). The 49-item TSEBQ was based on Hofer and Pintrich's (1997) general theoretical model of personal epistemology (see above). Thus, we wrote items to assess two dimensions concerning knowledge about climate change (what one believes knowledge about climate change is like) and two dimensions concerning knowing about climate change (how one comes to know about climate change). The 12 items written to assess beliefs concerning the certainty of knowledge about climate change focused on the degree to which participants considered knowledge about climate change to be tentative and evolving rather than true and certain (sample item: The knowledge about issues concerning climate is consistently changing). The 12 items written to assess beliefs concerning the simplicity of knowledge about climate change focused on the degree to which participants considered knowledge about climate change to consist of interrelated concepts and complex theories rather than an accumulation of specific facts and details (sample

item: Within climate research, various theories about the same will make things unnecessary complicated [reversed]). The 12 items written to assess beliefs regarding the source of knowledge about climate change concerned to what extent participants considered the self to be a source and constructor of knowledge rather than viewing knowledge about climate change to be transmitted from experts (sample item: With respect to climate problems, I feel I am on safe ground if I only find an expert statement [reversed]). Finally, the 13 items written to assess beliefs concerning how knowledge claims about climate change can be justified or evaluated focused on the degree to which participants considered it necessary to use rules of inquiry or reason and to critically evaluate and compare sources rather than being content with what feels right or firsthand experience (sample item: To check whether what I read about climate problems is reliable, I try to evaluate it in relation to other things I have learned about the topic), see Appendix C.

The reason we decided to develop a new topic-specific instrument for measuring epistemic beliefs instead of just adapting an existing instrument, for example, Hofer's (2000) domain-specific questionnaire (DFEBQ), to the topic of climate change, was that the instruments that we scrutinized (including the DFEBQ) had not clearly identified the four dimensions of the Hofer and Pintrich (1997) framework in prior factor-analytic studies. In constructing the TSEBQ, we adapted items from a range of existing instruments, in particular from the domain-general questionnaires of Schommer (1990), Schraw et al. (2002), and Wood and Kardash (2002), the domain-specific questionnaires of Buehl et al. (2002), Hofer (2000), and Trautwein and Lüdtke (2007), and the Internet-Specific Epistemological Questionnaire of Bråten, Strømsø, and Samuelstuen (2005). We fastidiously adapted only items that seemed closely tied to a theoretical description of the dimension in question (Hofer & Pintrich, 1997), also writing additional items that we agreed would be highly relevant to each of the four dimensions. For example, with respect to justification for knowing about climate

change, we particularly drew on the items used by Bråten at al. (2005) to measure justification beliefs, but also adapted some items that fell on the justification factor in Hofer's (2000) study. With respect to source of knowledge about climate change, in addition to existing instruments mentioned above, we also drew on Schraw and Bruning's (1996) effort to measure readers' epistemologies of text (i.e., transmission and transactional beliefs) when constructing the TSEBQ.

The participants were given the following written direction for the TSEBQ: "Issues concerning climate are highly topical and often mentioned in the media. We can read daily about issues such as climate change, pollution of the atmosphere, global warming, extreme weather, rise in ocean levels, and melting of ice in polar regions. This is material that we often encounter in newspapers and magazines, as well as on TV and radio. Most people who do research on climate have a background in natural science, for example in chemistry, biology, or meteorology. The following questions concern knowledge about climate and how one comes to know about climate. There are no right or wrong answers to these questions; it is your personal beliefs that interest us. Use the scale below to answer the questions. If you strongly agree with a statement, circle 10; if you strongly disagree, circle 1. If you more or less agree with a statement, circle the number between 1 and 10 that best expresses your belief." Higher scores on the TSEBQ-items were supposed to reflect more sophisticated epistemic beliefs. Therefore, the ratings of the items that were negatively worded were reversed before any statistical analyses were conducted.

It should be noted that the TSEBQ was not topic-specific in the sense that the items could not be adapted to another topic by replacing climate change with that topic. Rather, our approach parallels research on domain-specific beliefs, where more general questions have been applied to a particular domain to allow comparisons of epistemic beliefs across domains (Hofer, 2006). In the same way, the TSEBQ could be adapted to different topics when examining stability and variation in epistemic beliefs

across topics. Because our measures of topic knowledge and topic interest, respectively, contained items referring to different aspects of climate change (e.g., the greenhouse effect, climate gases), it could be argued that those measures were even more specific than the TSEBQ. Of course, this variation follows from the nature of the measures themselves, with asking a whole series of multiple-choice questions about climate change or asking people to rate their interest in climate change over and over again clearly not practical. However, while we utilized questions that could be adapted to other topics than climate change in the TSEBQ, we also took care to further specify various aspects related to climate change in the written direction for the inventory (see above).

We chose to target personal epistemology concerning climate change in the present study for several reasons. First, climate change is an expanding area of research, where knowledge is growing but still characterized by many open questions and conflicting scientific evidence. Second, the knowledge base for conclusions regarding climate change is publicly debated, at least in developed democratic societies, as are the methods used to build knowledge in the area. Third, climate change is an issue of vital importance with strong individual and social implications. Because topics concerning unsettled or controversial issues that are also related to people's health or safety may be particularly well suited to elicit epistemic thinking (Kolstø, 2001; Jungermann, Pfister, & Fischer, 1996), we expected that the participants in both countries had reflected somewhat on the issue of climate change and developed a personal stance on the nature of knowledge and knowing in the area.

Procedure

All the measures were group administered to the participants during regular lectures in the beginning of the autumn term. In Norway, the two Norwegian authors and three trained research assistants collected the data from all the Norwegian participants during one lecture; in Spain, the two Spanish authors collected the data

from the participants during three lectures, with 129, 35, and 52 participants, respectively, attending each lecture. The administration of the measures followed the same protocol in Norway and in Spain. Each participant received a folder with a demographic information sheet followed by three questionnaires in this order: (a) topic knowledge measure, (b) topic interest measure, and (c) personal epistemology measure. The participants were orally instructed that they should complete the questionnaires in the order they were presented in the folder. They were also asked to pay close attention to the written instruction at the beginning of each questionnaire. The participant were allowed as much time as they needed to complete the demographic information sheet and the questionnaire, and everyone finished within one lecture period of 45 minutes.

All three questionnaires were initially developed in Norwegian by the two Norwegian authors in collaboration with Marit Samuelstuen. To prepare the Spanish versions, several steps were taken. First, one of the Norwegian authors, fluent in Norwegian and English, translated the measures into English. The preliminary English versions were collectively reviewed by the four authors, all proficient in English (and two of them native Norwegian speakers), and later revised on the basis of this discussion. Next, one of the Spanish authors translated the measures from English to Spanish, with this translation reviewed by the other Spanish author and disagreements concerning the comparability of the versions solved through discussion. In translating into Spanish, the Spanish authors took great care to retain the accurate meaning of the items, and to make them easy to understand in the cultural context of the Spanish participants. Finally, a professor of English at the University of Valencia independently compared the English and the Spanish versions of the questionnaires and, on the basis of this, suggested some revisions of the Spanish translations that were taken into account.

2.2. RESULTS

Factor Analyses

The first research question, concerning the dimensionality of topic-specific personal epistemology, was addressed through principal-components factor analyses of the scores on the TSEBQ. We conducted separate factor analyses of the personal epistemology data for the Norwegian and Spanish participants, with this allowing us to explore the consistency of emerging factor solutions across cultural contexts. In the following, we first present the factor analyses with the Norwegian participants and then report on the factor analyses with the Spanish participants.

Norwegian participants. Prior to factor analyzing the data, we computed the internal consistency for the 49 items of the TSEBQ. Coefficient α was .74, with item—total correlations ranging from -.22 to .48. Seven items had negative item—total correlations, and six items had item—total correlations less than .10. Following Wood and Kardash (2002), we did not find it reasonable that some items should be unrelated or even negatively related to other items used to assess personal epistemology, and therefore eliminated those 13 items from further analysis, with this procedure also consistent with Hofer and Pintrich's (1997) idea about the multidimensional but still theory-like, interrelated nature of epistemic beliefs (see also, Hofer, 2004c). When we re-ran the reliability for the 36-item scale, a coefficient α of .82 was obtained. Next, principal component analysis was performed on the 36 items. Because we expected the factors to be correlated, we chose to conduct oblique rotation.

Although initial analysis showed that 10 factors met the Kaiser—Guttman retention criteria of eigenvalues greater than unity, with these factors explaining 58.1 % of the total sample variation, inspection of the scree plot indicated a four-factor solution consisting of one large factor with an eigenvalue of 5.32 and three other factors with eigenvalues greater than 2. The remaining six factors had eigenvalues ranging from

1.71 to 1.10. Both the size of the eigenvalues and the scree plot appeared consonant with a four-factor solution and, hence, we decided to examine this solution further. First, a four-factor solution was forced, with a principal component analysis with oblique rotation performed on all 36 items. After this analysis, 10 items were eliminated because they did not load at least .35 on any of the four factors or because they loaded significantly or equally on more than one factor. When a four-factor solution was forced for a second time, using the same procedure on the remaining 26 items, four factors with high loadings (>.40) and no overlap for any item were identified after eliminating two items loading on more than one factor. Thus, this four-factor solution included 24 items of the TSEBQ. The four factors had eigenvalues from 4.06 to 1.75 and explained 40.3 % of the total sample variation. In accordance with Hofer and Pintrich's (1997) general model, the four factors were labelled: Certainty of Knowledge About Climate Change, Simplicity of Knowledge About Climate Change, Source of Knowledge About Climate Change, and Justification for Knowing About Climate Change. The items assigned to each factor, as well as item-to-factor loadings and eigenvalues for each factor, are shown in Table 2.1.

Table 2.1.

Factor Analysis of the Topic-Specific Epistemic Beliefs Questionnaire—Norwegian Participants

Variables	Certainty	Simplicity	Source	Justification
What is considered to be certain knowledge about climate today, may be considered to be false tomorrow	.64			
Certain knowledge about climate is rare	.64			
The results of climate research are preliminary	.62			
Theories about climate can be disproved at any time	.61			
The knowledge about issues concerning climate is constantly changing	.59			
Problems within climate research do not have any clear and unambiguous solution	.55			
Certainty Eigenvalue = 2.66				
With respect to knowledge about climate, there are seldom connections among different issues (R)		.60		
Within climate research, accurate knowledge about details is the most important (R)		.59		
Within climate research, various theories about the same will make things unnecessary complicated (R)		.57		
Knowledge about climate is primarily characterized by a large amount of detailed information (R)		.56		
The knowledge about climate problems is indisputable (R)		.48		
There is really no method I can use to decide whether claims in texts about issues concerning climate can be trusted (R)		.43		
Simplicity Eigenvalue = 1.75				
I often feel that I just have to accept that what I read bout climate problems can be trusted (R)			.71	

Table 2.1 (continued)

When I read about issues concerning climate, the author's opinion is more important than mine (R)	.69	
With respect to climate problems, I feel I am on safe ground if I only find an expert statement (R)	.65	
When I read about climate problems, I only stick to what the text expresses (R)	.57	
My personal judgments about climate problems have little value compared to what I can learn about them from books and articles (R)	.52	
Source Eigenvalue =2.00		
To check whether what I read about climate problems is reliable, I try to evaluate it		.79
When I read about issues related to climate, I try to form my own understanding of the content		.77
To gain real insight into issues related to climate, one has to form one's own personal opinion of what one reads		.59
When I read about issues concerning climate, I evaluate whether the content seems logical		.51
To be able to trust knowledge claims in texts about issues concerning climate, one has to check various knowledge sourcers		.44
Within climate research, there are connections among many topics		.43
I understand issues related to climate better when I think through them myself, and not only read about them		.41
Justification Eigenvalue = 4.06		

The six items assigned to Certainty of Knowledge About Climate Change focus on the tentativeness and ambiguity of knowledge about climate change. All the items were originally written to assess the certainty dimension. High scores on this factor represent the belief that knowledge about climate change is provisional and ambiguous, and low scores represent the belief that knowledge about climate change is permanent and unambiguous.

The six items comprising Simplicity of Knowledge About Climate Change deal with the structure of knowledge about climate change, with four of these items originally written to assess the simplicity dimension and the two others written to assess certainty of knowledge and justification for knowing, respectively. High scores on this factor represent the view that knowledge about climate change is theoretical and complex, and low scores represent the view that knowledge about climate change consists of a loose collection of proven facts.

The five items comprising Source of Knowledge About Climate Change focus on where knowledge about climate change resides, with four of these items originally written to assess the source dimension and one item written to assess justification for knowing. High scores on this factor reflect the belief that personal judgments and interpretations are main sources of knowledge about climate change, and low scores reflect the belief that one should only rely on expert authors when reading about climate change.

Finally, the seven items assigned to Justification for Knowing About Climate Change concern how the trustworthiness of knowledge claims about climate change can be evaluated. Three of these items were initially written to assess justification for knowing, three items were written to assess source of knowledge, and one item was written to assess simplicity of knowledge. High scores on this factor reflect the idea that knowledge claims about climate change should be evaluated through independent, critical and logical thinking, as well as through the comparison of multiple related

sources, and low scores represent a rejection of the notion that knowledge claims need to be checked against reason or other sources. Presumably, the reason the three items written to assess source of knowledge loaded on this factor was that, in addition to other sources, students considered their own thinking to be a relevant source when evaluating knowledge claims about climate change. The item written to assess the simplicity dimension probably loaded on this factor because students considered the multiple sources they could draw upon when evaluating knowledge claims to be interconnected rather than isolated.

We also examined the reliabilities for the four factors emerging from the Norwegian TSEBQ-data. Cronbach's α for items loading on Certainty of Knowledge About Climate Change, Simplicity of Knowledge About Climate Change, Source of Knowledge About Climate Change, and Justification for Knowing About Climate Change were .70, .60, .71, and .71, respectively.

Spanish participants. The Spanish TSEBQ-data were analyzed with exactly the same procedure as were the Norwegian data. The computation of the internal consistency for all 49 items yielded a coefficient α of .68, with item—total correlations ranging from -.13 to .43. Seven items had negative item—total correlations, and eight items had item—total correlations less than .10. Coefficient α computed after the elimination of these 15 items were .81. Initial principal component analysis with oblique rotation on the remaining 34 items yielded 10 factors with eigenvalues greater than 1 that explained 62.2 % of the total sample variation. However, inspection of the scree plot suggested a four-factor solution with one large factor with an eigenvalue of 5.04 and three other factors with eigenvalues ranging from 3.67 to 2.27. The remaining six factors had eigenvalues ranging from 1.49 to 1.06. Because both the size of the eigenvalues and the scree plot suggested a four-factor solution, we then forced a four-factor solution on all 34 items. After this analysis, four more items were eliminated because they loaded significantly or equally on more than one factor. When a four-

factor solution was forced for a second time on the remaining 30 items, four factors with high loadings (>.37) and no overlap for any item were identified after eliminating one item loading on more than one factor. Thus, this solution included 29 items, which fell on four factors with eigenvalues ranging from 4.52 to 1.98, explaining 41.5 % of the total sample variation. The four factors were labelled: Certainty of Knowledge About Climate Change—Tentativeness, Certainty of Knowledge About Climate Change—Ambiguity, Source of Knowledge About Climate Change, and Justification for Knowing About Climate Change. The items assigned to each factor, item-to-factor loadings, and eigenvalues are shown in Table 2.2.

The six items assigned to Certainty of Knowledge About Climate Change—Tentativeness focus on the possibility to obtain permanent or stable knowledge about climate change. All six items were originally written to assess the certainty dimension, and five of them were also included in the certainty dimension identified with Norwegian participants. While high scores on this factor represent the belief that knowledge about climate change is only provisional, low scores represent the belief that knowledge about climate change is permanent.

The six items comprising Certainty of Knowledge About Climate Change—Ambiguity focus on the possibility to obtain unambiguous and unconditional knowledge about climate change. Three of these items were originally written to assess the certainty dimension, two were written to assess the simplicity dimension, and one was written to assess justification for knowing. High scores on this factor represent the view that knowledge about climate change is ambiguous and conditional, and low scores represent the belief that knowledge about climate change consists of unambiguous and unconditional truths.

The nine items assigned to Source of Knowledge About Climate Change concern beliefs about where knowledge about climate change originates or resides. Seven of these items were originally written to assess the source dimension; the two

others were written to assess the certainty and the justification dimension, respectively. Six of the items were common to the source dimensions identified with Norwegian and Spanish participants. While high scores on this factor reflect the belief that personal judgments and interpretations are main sources of knowledge about climate change, low scores represent the view that knowledge resides in outside expertise, from which it is transmitted via reading.

Finally, the eight items comprising Justification for Knowing About Climate Change focus on the evaluation of the trustworthiness of knowledge claims concerning climate change. Four of these items were originally written to assess the justification dimension, three were written to assess simplicity of knowledge, and one was written to assess source of knowledge. Five of the items were common to the justification factor identified with Norwegian and Spanish participants. High scores on this factor represent the view that knowledge claims about climate change should be evaluated through independent logical thinking, as well as through the comparison of multiple related or connected sources, and low scores represent a rejection of the idea that knowledge claims in the area need to be evaluated through reason or comparison of related sources. The reason the three items written to assess the simplicity dimension loaded on this factor was probably that the students emphasized the interconnected nature of the sources they could draw upon when evaluating knowledge claims about climate change. The loading of the item written to assess source of knowledge on this factor probably meant that the students believed that their own thinking was also a relevant source when evaluating knowledge claims.

The reliability estimates (Cronbach's α) for the items loading on the Certainty of Knowledge About Climate Change—Tentativeness, Certainty of Knowledge About Climate Change—Ambiguity, Source of Knowledge About Climate Change, and Justification for Knowing About Climate Change factors were .80, .60, .72, and .79, respectively.

Table 2.2

Factor Analysis of the Topic-Specific Epistemic Beliefs Questionnaire—Spanish Participants

Variables	Certainty Tentativeness	Certainty Ambiguity	Source	Justification
What is considered to be certain knowledge about climate today, may be considered to be false tomorrow	.81			
The only thing we know for certain about climate problems, is that nothing is certain	.77			
The results of climate research are preliminary	.74			
Theories about climate can be disproved at any time	.63			
Certain knowledge about climate is rare	.57			
The knowledge about issues concerning climate is constantly changing	.56			
Certainty- Tentativeness Eigenvalue = 4.52				
With respect to knowledge about climate, there are seldom connections among different issues (R)		.66		
Within climate research, there is agreement about what is true (R)		.64		
Research on climate change shows that most problems in the area have a correct answer (R)		.52		
The knowledge about climate problems is indisputable (R)		.46		
With respect to issues concerning climate, that the viewpoints are good is more important to me than hw one has arrived at them (R)		.46		
Knowledge about climate is primarily characterized by a large amount of detailed information (R)		.44		
Certainty-Ambiguity Eigenvalue = 1.98				

Table 2.2 (continued)

With respect to climate problems, I feel I am on safe ground if I only find an expert statement (R)	.69	
When I read about climate problems, I only stick to what the text expresses (R)	.65	
I often feel I just have to accept that what I read about climate problems can be trusted	.65	
When I read about issues concerning climate, the author's opinion is more important than mine (R)	.57	
My personal judgments about climate problems have little value compared to what I can learn about them from books and articles (R)	.55	
Ordinary people have no basis for speaking about issues concerning climate change	.49	
To understand climate problems, it is not sufficient only to read what experts have written about them	.45	
I understand issues related to climate better when I thing through them myself, and not only read about them	.38	
Climate researcher can find the truth about almost everything concerning climate (R)	.37	
Source Eigenvalue = 3.41		
To check whether what I read about climate problems is reliable, I try to evaluate it		.73
When I read about issues related to climate, I try to form my own understanding of the content		.73
To find out whether what I read about climate problems is trustworthy, I try to compare knowledge from multiple sources		.69
Within climate research, there are connections among many topics		.67
When I read about issues concerning climate, I evaluate whether the content seems logical		.63
Within climate research, many things hang together		.62
Within climate research, knowledge is complex		.42
To be able to trust knowledge claims in texts about issues concerning climate, one has to check various knowledge sources		.39
Justification Eigenvalue = 2.54		

Multiple Regression Analyses

The other research question, concerning the relationship of topic-specific epistemic beliefs with other variables, was addressed by performing four hierarchical multiple regression analyses for each sample, with the measures resulting from our factor analyses used as dependent variables in these analyses. In each analysis, gender was entered into the equation in step one. In addition, age was included as a predictor to control for any age differences in personal epistemology. In step two, we included topic knowledge and topic interest. Deletion of missing values resulted in 217 Norwegian participants available for the regression analyses.

Descriptive statistics (means, standard deviations, and coefficients of skewness) for predictors and outcome measures are shown for both samples in Table 2.3. These data indicated that all score distributions were approximately normal and, thus, appropriate for use in parametric statistical analyses.

Table 2.3

Descriptive Statistics for Variables Included in Hierarchical Regression Analyses

	Norwegian participants			*Spanish Participants*		
	M	*SD*	Swekness	*M*	*SD*	Swekness
Topic knowledge	7.24	2.41	.16	5.88	2.38	.38
Topic interest	4.89	1.77	.43	6.05	1.63	.03
Certainty beliefs	6.73	1.52	-.13			
Simplicity beliefs	6.56	1.33	-.27			
Source beliefs	5.95	1.66	-.25			
Justification beliefs	6.75	1.42	-.16			
Certainty-Tentativeness				5.95	1.57	.09
Certainty-Ambiguity				6.24	1.22	.02
Source beliefs				5.72	1.25	-.07
Justification beliefs				7.08	1.28	-.19

Norwegian participants. Table 2.4 shows the results of the hierarchical regression analysis for Certainty of Knowledge About Climate Change as well as that for Simplicity of Knowledge About Climate Change. In neither case did gender and age together explain a statistically significant amount of the variance in epistemic beliefs concerning climate change after step one, R^2 = .002, $F_{change}(2, 214)$ = .23, *ns* for the certainty factor, R^2 = .009, $F_{change}(2, 214)$ = .94, *ns* for the simplicity factor. After step two, with topic knowledge and topic interest also included in the equation, R^2 = .009, $F_{change}(2, 212)$ = .73, *ns* for the certainty factor, R^2 = .012, $F_{change}(2, 212)$ = 1.32, *ns* for the simplicity factor. Thus, in neither case did the addition of topic knowledge and topic interest result in a statistically significant increment in R^2.

Table 2.4

Results of Hierarchical Regression Analyses for Variables Predicting Certainty and Simplicity Beliefs Among Norwegian Participants

	Certainty beliefs			Simplicity beliefs		
	B	*SE B*	β	*B*	*SE B*	β
Step 1						
Gender	-.17	.26	-.04	-.01	.24	.00
Age	.00	.02	-.02	-.02	.02	-.09
Step 2						
Gender	-.16	.27	-.04	.05	.24	.01
Age	.00	.02	-.01	-.03	.02	-.11
Topic knowledge	.05	.05	.07	.05	.04	.09
Topic interest	-.06	.06	-.06	.04	.06	.05

Note. For certainty beliefs: R^2 = .002 for step 1 (*ns*), Δ R^2 = .007 for step 2 (*ns*); for simplicity beliefs: R^2 = .009 for step 1 (*ns*), Δ R^2 = .012 for step 2 (*ns*).

The results of the hierarchical regression analyses for variables predicting Source of Knowledge About Climate Change and Justification for Knowing About Climate Change, respectively, are shown in Table 2.5. After step one, with gender and

age in the equation, R^2 = .002, $F_{change}(2, 214)$ = .23, *ns* for the source factor. After step two, with topic knowledge and topic interest added to prediction of source beliefs by gender and age, R^2 = .14, $F_{change}(2, 212)$ = 16.87, p = .000. Thus, addition of topic knowledge and topic interest to the equation resulted in a statistically significant increment in R^2. Topic interest positively predicted source beliefs, β = .38, p = .000, with this indicating that participants more interested in the topic of climate change were also holding more sophisticated beliefs about knowing in the area. With respect to Justification for Knowing About Climate Change, gender and age did not account for a statistically significant proportion of the variance after step one, R^2 = .01, $F_{change}(2, 214)$ = 1.12, *ns*. However, the variables entered in step two accounted for additional variance, with R^2 = .20, $F_{change}(2, 212)$ = 25.22, p = .000 after step two. A statistically significant positive relationship was found for topic interest, β = .43, p = .000, with this indicating that high-interest participants were more likely to hold sophisticated beliefs concerning the justification of knowledge claims.

Table 2.5

Results of Hierarchical Regression Analyses for Variables Predicting Source and Justification Beliefs Among Norwegian Participants

	Source beliefs			Justification beliefs		
	B	*SE B*	β	*B*	*SE B*	β
Step 1						
Gender	.04	.21	.01	-.24	.25	-.07
Age	-.01	.02	-.04	.02	.02	.08
Step 2						
Gender	.16	.20	.05	-.06	.23	-.02
Age	-.02	.01	-.11	.00	.02	.00
Topic knowledge	.00	.03	.00	.02	.04	.04
Topic interest	.26	.05	.38***	.35	.05	.43***

Note. For source beliefs: R^2 = .002 for step 1 (*ns*), Δ R^2 = .14 for step 2 (p < .001); for justification beliefs: R^2 = .01 for step 1 (*ns*), Δ R^2 = .19 for step 2 (p < .001). ***p < .001.

Spanish participants. Table 2.6 shows the results of the hierarchical regression analyses for the two certainty factors. After step one, with gender and age in the equation, R^2 = .021, $F_{change}(2, 213) = 2.32$, *ns* for Certainty of Knowledge About Climate Change—Tentativeness. In this analysis, the addition of topic knowledge and topic interest in step two did not result in a statistically significant increment in R^2, with R^2 = .030, $F_{change}(2, 211) = .93$, *ns* after step two. With respect to Certainty of Knowledge About Climate Change—Ambiguity, R^2 = .031, $F_{change}(2, 213) = 3.39$, p = .036 after step one. In this step, age was a negative predictor of participants' certainty beliefs, β = -.18, p = .01. After addition of topic knowledge and topic interest in step two, R^2 = .087, $F_{change}(2, 211) = 6.50$, p = .002. Topic knowledge positively predicted certainty beliefs, β = .23, p = .001, whereas topic interest negatively predicted them, β = -.16, p = .020. Thus, more knowledgeable participants were more likely to believe that knowledge about climate change is ambiguous and conditional, whereas more interested participants were more likely to believe that there is only one correct answer to this issue.

Table 2. 6

Results of Hierarchical Regression Analyses for Variables Predicting Certainty—Tentativeness and Certainty—Ambiguity Beliefs Among Spanish Participants

	Certainty- Tentativeness			Certainty—Ambiguity		
	B	*SE B*	β	*B*	*SE B*	β
Step 1						
Gender	.14	.26	.04	.03	.20	.01
Age	-.05	.02	-.14*	-.05	.02	-.18*
Step 2						
Gender	.21	.27	.05	.15	.20	.05
Age	-.04	.02	-.13	-.04	.02	-.13*
Topic knowledge	.07	.05	.10	.12	.04	.23**
Topic interest	.00	.01	-.01	-.01	.00	-.16*

Note. For certainty-tentativeness beliefs: R^2 = .021 for step 1 (*ns*), Δ R^2 = .009 for step 2 (*ns*); for certainty—ambiguity beliefs: R^2 = .031 for step 1 (*ns*), Δ R^2 = .56 for step 2 (p < .01). *p < .05, **p < .01.

The results of the hierarchical regression analyses for variables predicting Source of Knowledge About Climate Change and Justification for Knowing About Climate Change, respectively, are shown in Table 2.7. After step one, with gender and age in the equation, R^2 = .034, $F_{change}(2, 213) = 3.76$, p = .025 for the source factor. In this step, age was a negative predictor of source beliefs, β = -.17, p = .015. After step two, with topic knowledge and topic interest added to the prediction of source beliefs, R^2 = .090, $F_{change}(2, 211) = 6.52$, p = .002. Again, topic knowledge was a positive predictor, β = .23, p = .001, whereas topic interest was a negative predictor, β = -.15, p = .026, with this indicating that high knowledgeable students were more likely than low knowledgeable students to view themselves as important sources of knowledge about climate change, whereas high-interest students were more likely than low-interest students to believe that knowledge about climate change resides in outside expertise. With respect to Justification for Knowing About Climate Change, gender and age together did not explain a statistically significant amount of the variance after step one, R^2 = .002, $F_{change}(2, 213) = .24$, *ns*. After step two, with topic knowledge and topic interest also included in the equation, R^2 = .18, $F_{change}(2, 211) = 23.07$, p = .000. Topic interest positively predicted beliefs about justification for knowing, β = .42, p = .000, with this indicating that the more interested participants were in the topic, the more they believed that knowledge claims about climate change should be evaluated through critical reasoning and comparison of multiple knowledge sources.

Table 2. 7

Results of Hierarchical Regression Analyses for Variables Predicting Source and Justification Beliefs Among Spanish Participants

	Source beliefs			Justification beliefs		
	B	*SE B*	β	*B*	*SE B*	B
Step 1						
Gender	.26	.21	.09	-1.18	1.73	-.05
Age	-.04	.02	-.17	.02	.15	0.1
Step 2						
Gender	.39	.21	.13	-1.38	1.60	-.05
Age	-.03	.02	-.12	-.03	.14	-.02
Topic knowledge	.12	.04	.24**	.02	.29	00
Topic interest	-.01	.00	-.15*	.22	.03	.42***

Note. For source beliefs: R^2 = .034 for step 1 (p < .05), Δ R^2 = .056 for step 2 (p < .01); for justification beliefs: R^2 = .002 for step 1 (*ns*), Δ R^2 = .18 for step 2 (p < .001).
*p < .05, **p < .001, ***p < .001.

2.3. DISCUSSION

The present research contributes to the literature on personal epistemology by presenting new findings concerning the dimensionality of topic-specific epistemic beliefs across cultures. First, our findings corroborate prior research focusing on domain-general and domain-specific levels by demonstrating the complex and multidimensional nature of epistemic beliefs even at the level of topic-specificity. Moreover, the factor analyses of the TSEBQ-scores that we conducted with Norwegian and Spanish participants indicated that the dimensionality of topic-specific personal epistemology was captured quite well by the categories included in Hofer and Pintrich's (1997) general theoretical model. That is, all four factors emerging from the Norwegian data corresponded to dimensions described by Hofer and Pintrich. In addition, three of these dimensions, concerning the certainty and source of knowledge as well as

justification for knowing, were also identified in the Spanish data. The reliability estimates for the factors obtained in both samples indicated that statistically sound measures could be constructed on the basis of the factors. Taken together, this suggests that the theoretical framework proposed by Hofer and Pintrich (1997) is appropriate for quantitatively studying personal epistemology on a topic-specific level.

The reason other researchers conducting factor analyses of epistemic belief data on a topic-specific level have not identified the four dimensions proposed by Hofer and Pintrich (1997) could be that most of those studies have used a semantic differential assessing associative-connotative aspects of personal epistemology (Kienhues et al. in press; Pieschl et al., 2008; Stahl & Bromme, 2007). Moreover, that Kienhues et al. did not identify the four dimensions when using Hofer's (2000) DFEBQ adapted to the topic of genetics is not surprising given that Hofer (2000) did also not identify those dimensions when using the domain-specific version of her instrument. In fact, that was one of our reasons for developing a new instrument for measuring topic-specific epistemic beliefs instead of adapting the DFEBQ to the topic in question (see *Materials* above).

Second, our cross-cultural comparison of the structure of the TSEBQ-data draws attention to the cultural embeddedness of topic-specific epistemic beliefs. Thus, even though considerable cross-cultural generalizability in dimensionality was demonstrated, with certainty, source, and justification dimensions identified in both Norway and Spain, there were also some notable differences between the two contexts. Specifically, beliefs about the simplicity of knowledge did not emerge as a distinct factor from the Spanish data, where, instead, beliefs about the certainty of knowledge split into two factors, one focusing on the tentativeness of knowledge and the other on the ambiguity of knowledge. Apparently, beliefs about the certainty of knowledge were particularly salient and important epistemic beliefs concerning climate change among the Spanish participants. While the exact reason why simplicity beliefs

may be more evident within the Norwegian cultural context and certainty beliefs more evident within the Spanish cultural context can only be discovered through further research, such cultural differences might be related to different emphasis thus far given to the topic of climate change in Northern and in Southern Europe. For example, because the negative consequences of global warming are supposed to be most pronounced in the northerly regions, the issue has been heatedly debated there by scientists, politicians, business and labor union leaders, and others for quite some time, with this possibly making issues concerning the complexity or simplicity of knowledge in the area more salient. At the same time, public debate about the issue in Spain may have focused more on the certainty aspect of knowledge about climate change, with questions concerning the stability and accuracy of such knowledge placing certainty beliefs in the forefront of students' minds. In any case, the fact that the two samples were from comparable student populations in Norway and Spain strengthens the assumption that cultural variables were at the root of observed differences in the dimensionality of epistemic beliefs.

It should be noted, however, that there were also differences in the specific contents and instructional practices that the two samples experienced, with this, possibly, influencing participants' epistemic beliefs. For example, the data for the Norwegian participants were collected during a course that included philosophy of science and research methodology, which might have increased their awareness of epistemic beliefs. One possible approach is to view this as a confound and try to disentangle the roles played by culture on the one hand and course content and instructional practice on the other by comparing students across cultures who are taught the same content in the same way, should such students really exist. We would argue, however, that a more reasonable approach is to view such differences in academic context as an inherent part of cultural differences. That said, it should be acknowledged that our study can not determine what precisely it is about the cultures

that may create the observed differences in the dimensionality of epistemic beliefs. With respect to assessment, such differences, whatever the reason, raise the question of whether methods and instruments for assessing personal epistemology needs to be adapted to specific cultures (cf., Bråten & Strømsø, 2005), a question that can only be answered through much further international cooperation in the area of personal epistemology (Maggioni et al., 2006).

Third, our regression of topic-specific epistemic beliefs on gender, topic knowledge, and topic interest also revealed some interesting similarities and differences across cultures. As expected, gender did not predict epistemic beliefs concerning climate change in any of the samples, with this consistent with the view that gender differences may be more pronounced when domain-general personal epistemology is assessed (Buehl et al., 2002). In regard to topic knowledge, this variable differentially predicted epistemic beliefs across cultures, with scores on two of the belief dimensions positively predicted by topic knowledge among the Spanish participants but no relationships found for topic knowledge among the Norwegians. Thus, while the positive relationships between topic knowledge and epistemic beliefs among the Spanish participants were consistent with our expectations, with more knowledgeable participants also more likely to hold sophisticated beliefs about knowledge and knowing, topic knowledge did not consistently predict epistemic beliefs, neither across nor within cultures, in this study. In regard to topic interest, we noted that this variable was a more consistent predictor of epistemic beliefs across cultures than was topic knowledge, with scores on two belief dimensions predicted by topic interest among the Norwegian participants and three dimensions predicted among the Spanish participants.

However, whereas topic interest was only a positive predictor among the Norwegians, it was both a positive and a negative predictor among the Spanish participants. In particular, the fact that high-interest Spanish students were more likely

to hold naïve beliefs concerning certainty as well as source of knowledge gave us a pause. Taking into consideration the generally low level of topic knowledge among the Spanish participants[2], this suggests that high topic interest in combination with insufficient topic knowledge may actually be maladaptive, for example, by leading people to view the issue in black and white and to seek support in external authority for their view. In terms of education, this suggests that high interest or enthusiasm without much knowledge about the topic should be cognitively tempered or canalized into more adaptive epistemic thinking by providing students with relevant background knowledge, for instance through readings or informed discussions about the issue. At the same time, however, topic interest was a strong positive predictor of scores on the justification for knowing dimension in both Norway and Spain, with this being consistent with the view that personal interest may serve to motivate strategic effort to think deeply about and monitor the understanding of information (cf., Krapp, 1999; Schiefele, 1998, 1999). Given the preliminary nature of our findings, as well as the important consequences personal epistemology may have when people try to understand a complex scientific topic such as climate change by studying multiple, even conflicting, information sources on the issue (Bråten, 2008), it is a great challenge for future researchers to gain a better understanding of the factors that may constrain or enhance adaptive topic-specific epistemic beliefs in particular cultures.

Although age was not focused in the theoretical framework of the study, we included this variable as a suitable control and found that in the Spanish sample, age was a negative predictor of three of the belief dimensions, indicating that younger students were more likely to hold sophisticated beliefs about climate change than were older students. There are a couple of possible reasons for this interesting finding, which runs counter to theory and research grounded in developmental psychology (e.g., King & Kitchener, 2004; Kuhn & Weinstock, 2002). One reason may be that younger Spanish students were likely to have more knowledge about climate change than older

Spanish students[3], possibly because they had more recently learnt about the topic as part of the high school curriculum. It is also conceivable, however, that younger students were more inclined to respond to the topic-specific epistemology items in the socially desired direction, with this resulting in more sophisticated beliefs among those students than among older ones.

Some limitations with the present study are important to mention. One concerns the way we chose to measure epistemic beliefs. The reason we used questionnaires with Likert-type scales was the suitability of this approach for conducting large-scale factor-analytic studies involving hundreds of participants, as well as our wish to compare our results with those of other studies using the same methodology. However, one consequence of our choice was that the dimensions that were identified in the two samples were limited by the content of the questionnaire and, thus, we cannot be sure that we were assessing and comparing all relevant dimensions of topic-specific personal epistemology across cultures. In other words, our methodology restricted participants' reports of epistemic beliefs to beliefs prelisted on the questionnaire even though they may have held other beliefs about the topic. Moreover, there are several other issues with using questionnaires and Likert-type rating scales to measure epistemic beliefs, such as whether those scales can adequately capture the highest level of sophistication involving a reconciliation or coordination of objectivity and subjectivity (e.g., Kuhn & Weinstock, 2002). Thus, it should be acknowledged that our methodology may have led us to compare a particular type or range of epistemic beliefs. Given such issues, future cross-cultural research on personal epistemology would probably profit from smaller-scale studies using more qualitative, dynamic assessments (cf., Schraw & Sinatra, 2004), at least in an initial phase where potential cross-cultural similarities and differences in the structure and nature of epistemic beliefs are explored (Bråten & Strømsø, 2005).

Moreover, multi-methods approaches combining quantitative and qualitative data sources may be valuable when assessing personal epistemology across cultures. For example, combining the use of questionnaires with in-depth interviewing about how individual items are understood in different cultures may lead to the development of more culturally sensitive measures, as well as to a triangulation of data allowing for a more complete picture of epistemic beliefs across cultures.

Another limitation of this study is that we cannot claim that our findings generalize to the whole student population in the respective countries, or even to the population of Norwegian and Spanish undergraduate students, respectively. In addition, our study of dimensionality in topic-specific personal epistemology across cultures was limited to the topic of climate change. It is therefore important that future researchers extend our contribution to encompass other student groups as well as other topics.

It could also be argued that some participants reported epistemic beliefs more in accordance with the prevalent or politically correct view on knowledge and knowing concerning climate change than with their own personal view. This possibility does not make it less reasonable to interpret the similarities and differences that we identified as culturally embedded, however. Because self-reports of epistemic beliefs on a questionnaire may differ from what participants actually do when dealing with a particular topic, that is, from their epistemic beliefs in action, one way to validate such self-reported beliefs is to compare them with ongoing epistemic judgment and monitoring as assessed through think alouds (Hofer, 2004c; Mason & Boldrin, 2008).

Despite the limitations, we maintain that our study may initiate an important line of cross-cultural research on topic-specific personal epistemology. Indeed, how people in different countries view knowledge and knowing about issues of vital importance, such as climate change, may be crucial for how those problems are understood and, eventually, solved. Questions concerning how knowledge and knowing about important

topics are conceptualized in different cultural contexts, as well as the factors that may constrain and enhance the development of more adaptive topic-specific epistemic beliefs, should therefore be more fully addressed in the wake of this preliminary work.

Notes

[1] The term Bildung is partly equivalent to the English term ‘liberal education’ but has stronger connotations to ideas about the education of character and the kind of personal growth that this implies (Standish, 2003)

[2] Please note that the level of topic knowledge among the Spanish participants (M = 5.88) was also statistically significantly lower than the level of topic knowledge among the Norwegian participants (M = 7.24), with $t(441) = 5.81$, $p = .000$..

[3] Whereas age and topic knowledge were unrelated in the Norwegian sample, a statistically significant negative correlation (r = -.14, p = .042) was observed in the Spanish sample.

CAPÍTULO 3

Understanding and Integrating Multiple Science Texts: Summary Tasks are Sometimes Better than Argument Tasks

ABSTRACT

One of the major challenges of a knowledge society is that students as well as other citizens must learn to understand and integrate information from multiple textual sources. Still, task and reader characteristics that may facilitate or constrain such intertextual processes are not well understood by researchers. In this study, we compare the effects of summary and argument essay tasks when undergraduates read seven different texts on a particular scientific topic, finding that an instruction to write summaries may lead to better understanding and integration than an instruction to write argument essays. We discuss several possible explanations for this result. We also found that beliefs about the certainty of knowledge in some instances can moderate the effect of task on comprehension performance.

INTRODUCTION

In a knowledge society, students are required not only to understand single texts, but also to understand and integrate information from multiple textual sources. Thus, students need new literacy skills involved in the processes of reading, comprehending, writing, and using multiple documents (Rouet, 2006), not only for academic success, but also in the world outside school. In the last decade, understanding multiple sources and intertextual integration processes have received increased attention from researchers. Most of the studies in the area have been conducted with history texts addressing controversial events presented from different and opposing points of view (Britt & Aglinskas, 2002; Britt, Rouet, Georgi, & Perfetti, 1994; Nokes, Dole, & Hacker, 2007; Rouet, Britt, Mason, & Perfetti, 1996; Rouet, Favart, Britt, & Perfetti, 1997; Wiley & Voss, 1999; Wineburg, 1991, 1994; Wolfe & Goldman, 2005). Some of those studies indicate that students can benefit from reading multiple documents because it promotes the construction of a deeper and more interconnected understanding than a single text presenting the same content (Britt & Aglinskas, 2002; Nokes et al., 2007; Wiley & Voss, 1999).

However, less is known about processes of comprehension and integration when trying to describe or explain scientific or social phenomena (Bråten & Strømsø, 2003; Cerdán & Vidal-Abarca, 2008), goals present in many academic settings, especially in science and social studies courses in high schools and colleges. In this paper, we therefore focus on the comprehension and integration of multiple information sources within the domain of science. In particular, we are interested in two specific conditions that might affect comprehension and integration, respectively, type of task

and readers' epistemological beliefs. With this in mind, we designed an experiment in which undergraduates with naïve and sophisticated epistemological beliefs about climate change read seven separate texts on this controversial scientific topic for the purpose of performing either a summary or an argument essay task. In this way, we could also look for an interaction effect of task with epistemological beliefs on multiple-text comprehension. Students' topic knowledge and topic interest were measured and used as covariates in the present study.

Tasks and Multiple Sources

Reading and writing tasks can affect the comprehension of a single text. For example, a number of studies (McNamara, Kintsch, Songer, & Kintsch, 1996; Mannes & Kintsch, 1987; McDaniel & Donnelly, 1996) have demonstrated that conditions that make reading more effortful, compared to less demanding conditions, can promote understanding of text content. Thus, McDaniel and Donnelly found that embedding an analogy in a text about a scientific principle improved understanding of the principle but not recall of the passage. In the same vein, McNamara and colleagues found that less coherent texts improved readers' performance on inference tasks but not their recall.

With respect to summary and argument essay tasks, they have both been regarded as important learning tools. Thus, a number of studies have demonstrated that summarizing text information may foster comprehension and learning (for review, see Bransford, Brown, & Cocking, 2000). Moreover, Wade-Stein and Kintsch (2004) argued that summary tasks may contribute to the construction of factual as well as conceptual knowledge because it serves to reinforce the memory representation of the content. In particular, summarization may facilitate the recall and comprehension of lower achieving students and those with learning disabilities. Argumentation has also been considered an important skill for students to learn and use. To present students with argument tasks can provide them an excellent opportunity for transforming and

integrating (Hemmerich & Wiley, 2002; Voss & Wiley, 2001; Wiley, 2001), as well as for self-explaining information (Chi, DeLeeuw, Chiu, & LaVancher, 1994), with this deeper processing, in turn, leading to better learning.

With respect to the reading of multiple texts, in particular, only a few researchers have explored the relationship between tasks and multiple-text comprehension (e.g., Britt & Sommer, 2004; Bråten & Strømsø, in press; Cerdán & Vidal-Abarca, 2008; Le Bigot & Rouet, 2007; Wiley & Voss, 1999). Wiley and Voss (1999) performed two experiments in which they instructed students to write arguments, narratives, summaries, or explanations when reading either a set of documents or the same information presented as a textbook chapter. In both experiments, they found that writing arguments was more effective for drawing inferences and transforming information than the other task conditions, but no differences were apparent with respect to repeating text information. Moreover, students who read in order to write arguments gained deeper and more integrated understandings of the topic than did the students in the other three task contexts. Argument writing tasks were found to be especially beneficial when students constructed arguments from multiple documents rather than from a textbook chapter. Thus, students reading multiple documents and writing arguments seemed to gain the best understanding of the topic. Also, Le Bigot and Rouet (2007) found that students instructed to write arguments produced essays with more transformed information than did students instructed to write summaries. However, Bråten and Strømsø (in press) found that students reading multiple texts in order to construct arguments or summarize information gained better understanding than those reading to produce a general overview, but no differences were found between students reading to construct arguments and those reading to summarize the content of the texts. Britt and Sommer (2004) showed that the extent to which readers formed an integrated representation when reading two texts about a historical event was influenced both by task

instructions given before reading and by intervening tasks, with instructions to integrate and intervening tasks in the form of macro-level summary writing and macro-level question answering seemingly facilitating text integration. Finally, Cerdán and Vidal-Abarca (2008) found that asking students to provide global explanations for the phenomena described in three texts resulted in a deeper and more integrated understanding than asking them more specific questions that could be answered by searching for, finding, memorizing, and reproducing isolated bits of information.

In summary, existing research suggests that tasks which promote the elaboration of relevant text content (e.g., to write arguments or explain phenomena) can facilitate a deeper and more integrated text understanding, whereas tasks that can be performed with a more superficial representation of the text (i.e., a textbase) do not necessarily lead to better understanding. However, research that directly compares the effect of summary and argument tasks on the understanding of multiple documents is still limited and the findings are somewhat inconsistent. For example, whereas Wiley and Voss (1999) found the argument task to result in better understanding, no difference between argument and summary tasks was found in the Bråten and Strømsø (in press) study. Possibly, such inconsistency may be due to differences with respect to the complexity of the text material, readers' prior knowledge about the topic of the texts, their personal epistemology, and the exact nature of the task instructions (e.g., just asking readers to summarize information versus asking them to produce an elaborative summary of relevant content). In this study, we tried to clarify this important issue by comparing the effects of the two tasks (i.e., summary versus argument essay) on both superficial and deep-level text comprehension, including readers differing with respect to personal epistemology and also statistically controlling for the potential effects of topic knowledge and topic interest.

Reader Characteristics and Multiple Sources

We were interested not only in how characteristics of the task might affect students' multiple-text comprehension, but also in how characteristics of the reader might affect it, focusing on the reader characteristic of personal epistemology. Personal epistemology concerns beliefs that individuals hold about knowledge and the process of knowing (Hofer & Pintrich, 1997), with educational psychologists referring to personal epistemology as a multidimensional system of beliefs (Hofer & Pintrich, 1997; Schommer, 1990). In the currently most influential framework for thinking about the dimensionality of personal epistemology, Hofer and Pintrich (1997) proposed two dimensions concerning the nature of knowledge (certainty and simplicity of knowledge) and two dimensions concerning the nature or process of knowing (source of knowledge and justification for knowing). *Certainty of knowledge* ranges from the belief that knowledge is absolute and unchanging to the belief that knowledge is tentative and evolving. *Simplicity of knowledge* ranges from the belief that knowledge consists of an accumulation of isolated facts to the belief that knowledge consists of highly interrelated concepts. The dimension *source of knowledge* ranges from the conception that knowledge originates outside the self and resides in external authority to the conception that knowledge is actively constructed by the person. Finally, the dimension of *justification for knowing* ranges from justification of knowledge claims through observation and authority to the use of rules of inquiry and the evaluation and integration of different knowledge sources. Please note that these dimensions are described from what has traditionally been labelled the naïve to the sophisticated end of the continuum.

The issue of domain-generality versus domain-specificity in students' epistemological beliefs has been much debated (for reviews, Buehl & Alexander, 2001; Muis, Bendixen, & Haerle, 2006). This issue concerns the degree to which epistemological beliefs are independent of academic domain, for instance, whether

students are likely to hold the same beliefs about knowledge and knowing in physics as in history. Whereas initial research was based on the assumption that epistemological beliefs are independent of academic domain, it seems to be accepted in the current literature that students hold both domain-general and domain-specific beliefs (Muis et al., 2006). However, the distinction between domain-specific and topic-specific epistemological beliefs, for example, between beliefs regarding knowledge and knowing in physics (domain-specific) and knowledge and knowing in thermodynamics (topic-specific), has received less attention. That said, several researchers have lately started to focus on topic-specific personal epistemology (Kienhues, Bromme, & Stahl, in press; Pieschl, Stahl, & Bromme, 2008; Stahl & Bromme, 2007; Trautwein & Lüdtke, 2007). For example, Trautwein and Lüdtke (2007) used questionnaire items to examine students' epistemological beliefs about specific scientific theories, such as biological theories concerning natural selection and extinction of the dinosaurs, showing that epistemological beliefs differed considerably across theories. Stahl and Bromme (2007) used a semantic differential measure to assess epistemological beliefs concerning different biological topics, finding significant differences in epistemological beliefs between topics, specifically, that knowledge about plant identification was believed to be more unstructured and stable than knowledge about genetics. In the present study, we continued this line of research by focusing on epistemological beliefs concerning a particular scientific topic, using a questionnaire based on Hofer and Pintrich's (1997) multidimensional framework.

There is currently abundant evidence demonstrating the important role played by personal epistemology in students' academic performance (for review, see Bråten, in press). Specifically, research on the relationship between epistemological beliefs and the reading of single texts indicates that less sophisticated beliefs about the nature of knowledge and knowing may be related to poorer comprehension performance (e.g., Buehl & Alexander, 2005; Kardash & Howell, 2000; Schommer, 1990). Moreover, some

authors (Hartley & Bendixen, 2001; Spiro, Feltovich, & Coulson, 1996) have suggested that epistemological beliefs may be particularly important when students deal with complex learning tasks. Consistent with this view, it is conceivable that in the complex task environment of reading multiple sources, the effect of beliefs about knowledge and the process of knowing on comprehension may be greater than when reading single texts. Preliminary empirical evidence was provided by Jacobson and Spiro (1995), who found that only students who preferred working with complex knowledge in multiple ways and valued active learner construction of knowledge were able to profit from the reading of multiple texts. In that study, personal epistemology was found to moderate the effect of multiple-text reading on deeper understanding but not memory for facts. Likewise, Rukavina and Daneman (1996) found that students holding more sophisticated beliefs about the complexity of knowledge were better equipped to integrate across two texts presenting conflicting information about a scientific topic. More recently, Bråten, Strømsø, and Samuelstuen (in press) examined the effect of dimensions of topic-specific personal epistemology on the understanding of multiple texts about a scientific issue, finding that sophisticated simplicity beliefs, that is, viewing knowledge as complex, positively affected multiple-text understanding, whereas sophisticated source beliefs, that is, viewing knowledge as personal construction, negatively affected it (see also, Strømsø, Bråten, & Samuelstuen, in press).

As mentioned earlier, we were interested in examining whether task might interact with epistemological beliefs. To the best of our knowledge, this question has previously been addressed in only one related study by Bråten and Strømsø (in press). They found that effects of task depended on participants' certainty beliefs, with participants characterized by more sophisticated beliefs, considering knowledge to be tentative, more able to profit from the argument task than were participants characterized by more naive beliefs, considering knowledge to be certain. This suggests that argument tasks are not optimal for every reader, regardless of individual

characteristics, with this important issue carrying not only theoretical but also educational implications.

Of course, other characteristics of the reader can influence text understanding as well. To best isolate variance resulting from task and topic-specific epistemological beliefs, as well as from their interaction, we also assessed participants' prior knowledge and interest at the same level of specificity as personal epistemology, that is, concerning the topic of climate change. With respect to prior knowledge, much research on text comprehension indicates that readers use prior knowledge in combination with the content and the structure of the text to construct meaning (Goldman, 1997; Graesser, Gernsbacher, & Goldman, 1997; Kintsch, 1998). Alexander and Jetton (2000) suggested that no other individual-difference factor influences students' understanding and recall more than their knowledge about the topic of reading. With respect to topic interest, researchers have demonstrated that well-developed personal interest in an area facilitates learning and comprehension (for review, see Hidi, 2001). For example, students reading about personally interesting topics have been shown to learn more from text (Schiefele, 1999), and there is also some indication that personal interest affects the quality of text-based learning by leading to more elaborate and deeper text processing (Krapp, 1999; Schiefele, 1998, 1999).

3.1. OBJECTIVES AND HYPOTHESES

Given this theoretical backdrop, the current research had the following objectives: (a) to examine the effect of task, specifically, summary versus argument essay tasks, on students' comprehension and integration of multiple documents about the topic of climate change, and (b) to examine whether the effect of task is dependent on students' personal epistemology concerning the same topic. Based on prior research and theoretical assumptions cited above, we formulated two hypotheses. First, we hypothesized that the argument essay task would facilitate a deeper and more

integrated text understanding than the summary task. This is because an argument task has been shown to promote the transformation and elaboration of relevant text content to a greater extent than a summary task, which apparently can be performed with a more superficial representation of the text (cf., Chi et al., 1994; Hemmerich & Wiley, 2002; Wiley & Voss, 1999). Second, we hypothesized an interaction between students' personal epistemology and the task condition. Specifically, it was predicted that the argument task would be more beneficial to students holding sophisticated epistemological beliefs than to those holding naïve beliefs. Crucial to our second hypothesis is the assumption that students holding sophisticated epistemological beliefs are more inclined to engage in the constructive and integrative activities required to perform an argument task than are students holding naïve beliefs (cf., Bråten & Strømsø, in press).

3.2. METHOD

Participants

Initially, 87 first-year psychology and teacher education undergraduates from the Catholic University of Valencia and the University of Valencia participated in the study for extra course credit. The sample consisted of 61 females and 26 males, with an overall mean age of 19.3 (*SD*= 3.7). From this sample, which was administered a topic-specific personal epistemology questionnaire (see below), the 27 students with the highest (*M* = 329.19, *SD* = 20.46) and the 26 students with the lowest (*M* = 265.19, *SD* = 17.56) total scores on the questionnaire were selected for further participation. The 27 students with the highest scores ranked above the 70th percentile in the distribution of scores based on all 87 students, and the 26 students with the lowest scores ranked below the 30th percentile. Higher total personal epistemology scores were considered to represent more sophisticated epistemological beliefs and lower total scores were considered to represent more naïve beliefs, and the reason why 34

students with medium total scores (*M* = 295.76, *SD* = 6.74) were not selected for participation in the second part of the study, was that we wanted to maximize differences among participants with respect to epistemological sophistication. Among the 53 participants, there were 39 females and 14 males, with an overall mean age of 19.4 years (SD = 4.1). Eighteen of the participants in the final sample were enrolled in a psychology program at the Catholic University of Valencia, and 35 were students from the School for Teachers at the University of Valencia. All of the 53 participants had Spanish as their first language.

Materials

All materials used in the experiment were initially developed in Norwegian by the two Norwegian authors in collaboration with Marit Samuelstuen. Spanish versions were prepared following several steps. First, materials were translated into English by one of the Norwegian authors and the preliminary English versions were collectively reviewed by the four authors, all proficient in English, and later revised on the basis of this discussion. Next, the two Spanish authors translated the materials into Spanish, taking great care to retain the accurate meaning while making some necessary cultural adaptations. A professor of English at the University of Valencia compared the Spanish and the English versions and suggested some minor changes which were taken into account. Finally, all texts were reviewed by a science professor at the University of Valencia, who was also an expert on global warming. Only minor changes were made in accordance with this final review.

Personal epistemology measure. To assess students' personal epistemology in this study, we used the Topic-Specific Epistemic Belief Questionnaire (TSEBQ) described by Bråten, Gil, Strømsø, and Vidal-Abarca (2008). The TSEBQ consists of 49 items written to reflect Hofer and Pintrich's (1997) general theoretical model of personal epistemology, at the same time measuring students' personal epistemology at

a topic-specific level. Factor analysis conducted in prior research (Bråten et al., 2008) with 216 Spanish psychology and education undergraduates indicated that items loaded on four separate factors that explained 41.5% of the total sample variation. In that research, six items were assigned to a factor labelled *Certainty of Knowledge about Climate Change—Tentativeness*, with high scores on this factor representing the belief that knowledge about climate change is only provisional and low scores representing the belief that knowledge about climate change is permanent (sample item: *What is considered to be certain knowledge about climate today, mey be considered to be false tomorrow*). Six items were assigned to a factor called *Certainty of Knowledge about Climate Change—Ambiguity*. High scores on this factor represented the view that knowledge about climate change is ambiguous and conditional and low scores represented the belief that knowledge about climate change consists of unambiguous and unconditional truths (sample item: *The knowledge about climate problems is indisputable* [reversed]). Nine items were assigned to a factor labelled *Source of Knowledge about Climate Change*, with high scores on this factor representing the belief that personal judgments and interpretations are main sources of knowledge about climate change, and low scores representing the view that knowledge resides in outside expertise, from which it is transmitted via reading (sample item: *With respect to climate problems, I feel I am on safe ground if I only find an expert statement* [reversed]). Finally, eight items were assigned to *Justification for Knowing about Climate Change*. While high scores on this factor represented the view that knowledge claims about climate change should be evaluated through independent logical thinking, as well as through the comparison of multiple related or connected sources, low scores represented a rejection of the idea that knowledge claims in the area need to be evaluated through reason or comparison of related sources (sample item: *To find out whether what I read about climate problems is trustworthy, I try to compare knowledge from multiple sources*); See Appendix C.

The measures used in the present study to assess dimensions of topic-specific personal epistemology were based on the factor analysis of the TSEBQ reported in Bråten et al. (2008). The participants rated each item on a 10-point anchored scale (1 = *strongly disagree*, 10 = *strongly agree*), with higher scores supposed to represent more sophisticated epistemological beliefs. In the present research, the reliability estimates (Cronbach's α) for the scores on the measures of *Certainty of Knowledge about Climate Change-Tentativeness, Certainty of Knowledge about Climate Change-Ambiguity, Source of Knowledge about Climate Change, and Justification for Knowing about Climate Change* were .77, .63, .72, and .76 , respectively.

Topic knowledge measure. To assess students' prior knowledge about climate change, we used a multiple-choice test consisting of 17 items with five response options for each item (See Appendix A). The content of the items referred to concepts and information central to the issue of climate change that were discussed in the seven texts (e.g., the greenhouse effect, climate gases, and the Kyoto Protocol) (sample item: *The Kyoto Protocol deals with a) trade agreements between rich and poor countries, b) reduction in the discharge of climate gases, c) the pollution of the Pacific Ocean, d) protection of the ozone layer, e) limitations on international whaling).* Taken together, the 17 items of the measure assessed both factual knowledge and conceptual understanding with respect to climate change. (For more information concerning the design and content validity of this measure, see Bråten et al., in press.)

Participants' topic knowledge score was the number of correct responses out of the 17 items. The test-retest reliability of the scores on the topic knowledge measure was computed in an independent sample of first-year psychology undergraduates (*n* = 80), with two weeks between the test and the retest. This yielded a reliability estimate (Pearson's *r*) of .73.

Topic interest measure. To measure participant's personal interest and engagement in issues and activities concerning climate change, we used a 12-item measure, where participants indicated their level of interest or engagement by rating each item on a 10-point Likert-type scale ranging from *not all true of me* (1) to *very true of me* (10); see Appendix B. Half of the items allowed participants to express their interest in the topic without obligation, that is, without reporting any active engagement or involvement in addressing the problem of climate change (sample item: *I am interested in what conditions influence the Earth's climate*). However, the other half of the items focused more on participants' active engagement and involvement in the issue, thus reflecting their willingness to act for the benefit of the Earth's climate (sample item: *I am concerned with how I myself can contribute to the reduction of environmental pollution*). Participants' topic interest score was the sum of their ratings for all of the items. The reliability (Cronbach's α) for the scores on this measure was .93.

***Texts*.** Seven authentic texts from different Norwegian sources were used. In the Spanish versions of the texts, authors and publishing channels were changed to create comparable national sources. Each text first presented information about the document's source (i.e., author, publisher, and publication date). The seven texts were presented to the participants in random order and they could read them in any order they preferred. Table 3.1 provides an overview of the seven texts that were used in the present study (See also Appendix D).

Table 3. 1

Overview of the Seven Texts

No.	Type of text	Publisher	Author	Content	*n* words
1.	Textbook in nature studies for upper secondary education	Publishing house	Teachers in upper secondary	Explanation of the natural greenhouse effect and the manmade greenhouse effect in relatively neutral, academic terms.	464
2.	Popular science text	Center for International Climate and Environmental Research	Not given	Focus on manmade discharges of climate gases into the atmosphere and their contribution to observed climate changes.	345
3.	Popular science article	University of Barcelona	Professor of theoretical astrophysics	Argues that climate changes to a large extent are steered by astronomical conditions and therefore due to natural causes.	332
4.	Newspaper article	Spanish liberal daily	Journalist	Description of the negative consequences of global warming in terms of a potential weakening of ocean currents in the North Atlantic and a melting of ice around the poles.	397
5.	Newspaper article	Spanish conservative daily	Journalist	Description of the positive consequences of a warmer climate in northerly regions in terms of an ice free sea route through the Northwest Passage and the access to natural resources now concealed under the Arctic ice.	299
6.	Public information text	Spanish Pollution Control Authority	Not given	Discussion of international cooperation within the framework of the UN as a way to reduce the discharges of climate gases.	379
7.	Project presentation	Norwegian oil company	Not given	Description of new technology that could reduce the discharges of carbon dioxide into the atmosphere.	417

Apart from the more neutral textbook excerpt, the six other texts contained partly conflicting information, with two texts presenting different views on the causes of

global warming (manmade versus natural), two texts presenting different views on the consequences of global warming (negative versus positive), and two texts presenting different views on the solutions to global warming (international cooperation versus new technology).The texts about climate change were selected because (a) the participants were likely to have some, but not extensive, prior knowledge of the topic; (b) the texts represented different kinds of authentic source materials that educated adult readers typically encounter; and (c) the discussion of this highly topical scientific phenomenon from multiple perspectives, because of its strong individual and social implications, was likely to elicit interest and reflection on part of the readers.

Writing tasks. After reading, participants first wrote either summaries or argument essays depending on the experimental condition (see below). The same coding system was used for scoring the summaries and the argument essays. Following Magliano, Trabasso, and Graesser's (1999) procedure, we first segmented every summary and argument essay into idea units. An idea unit contained a main verb that expressed an event, activity, or state. If an utterance had two verbs and one agent, it was treated as having two separate idea units. Infinitives and complements were included with the main verb (Magliano et al., 1999). Following segmentation, all segments were coded to indicate the degree of transformation and integration in students' compositions, respectively. With respect to transformation, each idea unit was coded as representing one of four types of transformation of original text content. Inspired by the coding system developed by Wiley and Voss (1996), idea units were coded as paraphrases if students used their own words without changing the meanings expressed in the source material (e.g., *Without the sun we would not have greenhouse effect, which is a prerequisite for us having liveable conditions on our planet* [from original text 1]/*Without the sun there would not be greenhouse effect, which plays a vital role in maintaining the necessary conditions for life on Earth* [from student summary]). Idea units were coded as elaborations if they contained some information

from the source material in combination with some information from prior knowledge (e.g., *The USA and Australia have chosen to remain outside* [from original text 6]/ *The USA and Australia had not ratified the protocol because of the costs for their economies* [from student argument essay]). Idea units were also coded as elaborations if they combined two or more pieces of information, either within or across texts, which were not connected in the source material (e.g., *This is due to the fact that we have increased our discharges of CO_2 into the atmosphere through the burning of large quantities of oil, gas and coal* [from original text 1] and *Warmer climate presents new opportunities* [from original text 4]/*The increase in mankind's discharges of CO_2 could also result in positive consequences* [across-text combination from student argument essay]). Idea units were coded as *additions* if they contained only related information from prior knowledge or personal opinions about climate change (e.g., *I have no trust in the fulfilment of the Kyoto Protocol* [personal opinion from student argument essay]). Moreover, we supplemented the coding system created on the basis of Wiley and Voss' (1996) work with the category of *misconceptions.* Idea units were coded as misconceptions if they contained false statements in relation to the content of the source material (e.g., *This can result in more of the heat being stopped from escaping from the earth* [from original text 1]/*The manmade greenhouse effect permits radiated heat to leave the earth in an easier way* [from student summary]). We counted the number of different paraphrases, elaborations, and additions, as well as the number of different misconceptions, in each student's summary or argument essay. A global score indicating the degree of transformation was computed by adding the number of paraphrases, elaborations, and additions and subtracting the number of misconceptions from this sum score. In doing this, we decided to award two points for each elaboration and one point for each paraphrase or addition because the elaborations can be considered to reflect a greater degree of transformation in the sense of Wiley and Voss (1996) than both paraphrases and additions.

With respect to integration, we focused on the number of sources used by students and their merging of information from those sources. With respect to number of sources, many students seem to rely too heavily on one or two documents or perspectives in their essay writing (Britt, Wiemer-Hastings, Larson, & Perfetti, 2004). According to Britt et al. (2004), the use of material from a variety of different sources in an essay may indicate "content integration from multiple sources" (p. 363). In this study, we therefore identified where every idea unit in a student's summary or argument essay came from and then simply counted the number of different texts that the student drew upon in their writing. Thus, while a score of seven suggests a complete coverage of the texts in our set, a score of zero suggests a lack of content coverage. With respect to the merging of information, we followed the procedure of Britt and Sommer (2004) and counted the number of switches between sources in student summaries or argument essays. That is, if an essay contained 20 idea units altogether, and the first five idea units came from text 1, the next five idea units came from text 3, the next eight units came from text 7, and the last two units came from text 3, this would count as three switches and indicate relatively poor integration.

First, one of the Spanish authors coded each summary and argument essay with respect to transformation and integration, using the coding system for each aspect detailed above. Second, a doctoral student of psychology independently rated a random subset of summaries and argument essays (33 %) using the same coding systems, with this resulting in an overall interrater agreement of 85 %. Disagreements in the coding were discussed by raters and consensus was reached in all cases through joint reflection on the criteria of the coding system.

Text understanding measures. Readers' memory for text content was measured with a *sentence verification task* (SVT) following Royer, Carlo, Dufresne, and Mestre's (1996) procedure. This task included 34 sentences (10 originals, 9 paraphrases, 7 meaning changes, and 8 distractors), and participants were instructed

to mark a sentence *yes* if it had the same meaning as a sentence in one of the texts (i.e., an original or a paraphrase) and *no* if it had a different meaning (i.e., a meaning change or a distractor), see Appendix E. Participants' score on this measure was the number of correct responses out of the 34 items. The reliability (Cronbach's α) for the participants' scores on this task was .71.

To assess participants' deeper understanding of each single text we use an *intratextual inference verification task* (IntraVT), again following Royer et al. (1996). The IntraVT consisted of 29 items that were constructed by combining information from different sentences within one of the texts to form either a valid or an invalid inference. There were 16 valid and 13 invalid inferences, and participants were instructed to mark those sentences *yes* that could be inferred from material presented in one of the texts and those sentences *no* that could not be inferred from material presented in one of the texts, see Appendix F. Participants' score on this task was the number of correct responses out of the 29 items. The reliability (Cronbach's α) for the scores on this task was .65. While the reliability estimate for the scores on the IntraVT was somewhat lower than desirable, as was the reliability estimate for the scores on the measure of certainty of knowledge about climate change—ambiguity (see above), reliability estimates in the .60s can still be considered acceptable with measures developed and used for research purposes (Nunnally, 1978).

Finally, we used an *intertextual inference verification task* (InterVT) to measure participants' ability to draw inferences across texts. The task consisted of 26 statements, 14 of which could be inferred by combining information from at least two of the texts (i.e., valid inferences), and 12 of which could not be inferred by combining information from at least two of the texts (i.e., invalid inferences). The participants were instructed to mark the valid inferences *yes* and the invalid inferences *no,* see Appendix G. Participants' score on the InterVT was the number of correct responses out of the 26 items. The reliability (Cronbach's α) for the scores on this task was .71.

Further information about the design and validity of the InterVT, as well as a number of sample items for all the three types of verification tasks used in the present study, are contained in prior work (Bråten & Strømsø, in press; Bråten et al., in press; Strømsø et al., in press).

Procedure

The 87 students of the initial sample were group administered the measures of topic-specific epistemological beliefs, topic knowledge, and topic interest during a 50-min regular lecture. All students received a folder with the three questionnaires and were orally instructed to answer each questionnaire in the same order as they were presented in the folder. Each questionnaire started with a short written instruction. The participants were allowed as much time as they needed to answer the questionnaires. The 53 students that we categorized as sophisticated (n = 27) and naïve (n = 26) with respect to personal epistemology, based on the highest and lowest total scores on the TSEBQ, were selected for participation in the second part of the study. Half of the participants categorized as holding sophisticated epistemological beliefs and half of the participants categorized as holding naïve epistemological beliefs were randomly assigned to the summary condition, and half of the participants in each epistemology group were randomly assigned to the argument condition. The participants in the final sample completed the experimental tasks individually in groups of 10 in a university lab, reading the texts and writing the summaries and argument essays using a computer application called *Read&Answer*. This application presented each text on two sequential pages. A simple interface allowed participants to navigate among texts and pages within a text. The participant saw one page of text on the screen at a time, with all text on that page masked except the segment currently selected (i.e., unmasked) by the participant. After reading, participants wrote summaries or argument essays on a blank screen.

In the experimental session, participants were first trained for 10-15 minutes to use *Read&Answer* with tasks similar to the experimental tasks, using different and shorter documents. All the participants in a group of 10 belonged to the same condition, were given the same oral instruction, and did not know anything about the other condition.

After training, students were asked to complete the experimental tasks, consisting of reading seven separate texts about climate change and then writing either a summary or an argument essay using the *Read&Answer*. They first read a written instruction for either the summary or the argument task on a computer screen. The written instruction for the participants in the summary condition (n = 25) was *Imagine that you have to write a brief report to other students that summarizes how climate changes may influence life on Earth and what are the causes of climate changes*. The participants in the argument condition (n = 28) were given the following written instruction before reading the texts: *Imagine that you have to write a brief report to other students where you express and justify your personal opinion about how climate changes may influence life on Earth and what are the causes of climate changes.* In addition, participants in both conditions were instructed: *Base your report on information included in the following seven texts. Use the most relevant information, and try to express yourself clearly and to elaborate the information—preferably in your own words*. All the participants were also informed that they were free to read and re-read the documents in the order they preferred. Finally, students were informed that they would be allowed 35 minutes to work on the texts and 15 minutes to write either the summary or the argument essay, and that they would not be able to look back to the texts while writing the summary or argument essay. Please note that only the instruction for text reading varied among participants.

After reading and writing, participants were administered the SVT, the IntraVT, and the InterVT on paper. They were allowed as much time as they needed to

complete the three measures of text understanding. All students completed the experimental session within 100 minutes.

3.3. RESULTS

To test our hypothesis concerning the facilitative effect of the argument essay in relation to the summary task on the comprehension and integration of information from multiple texts, as well as our hypothesis concerning the interaction between personal epistemology and task condition, we first performed four separate 2 x 2 between-subjects analyses of covariance (ANCOVAs) on each of the three text understanding measures (i.e., SVT, IntraVT, and InterVT). In each analysis, independent variables were one of the four dimensions of topic-specific epistemological beliefs (naïve and sophisticated) and task (argument and summary).

Epistemology groups were formed according to a median split on the dimension in question. Participants with scores below and at the median were classified as holding naïve beliefs on that particular dimension; participants with scores above the median were classified as holding sophisticated beliefs on the same dimension. In the first ANCOVA, epistemology groups were formed according to a median split on the certainty of knowledge—tentativeness dimension, in the three other ANCOVAs, they were formed according to median splits on the dimensions of certainty of knowledge—ambiguity, source of knowledge, and justification for knowing, respectively. Thus, even though the selection of participants for our experiment was based on differences in overall epistemology concerning climate change, we decided to perform separate ANCOVAs for epistemology groups formed on the basis of differences in these four dimensions. The reason for initially classifying participants as naïve and sophisticated on the basis of their scores on the entire TSEBQ was the lack of criteria for choosing a specific dimension on which to base this classification (cf., Bråten & Strømsø, 2006). Still, classifying participants according to their scores on specific dimensions when

testing our hypotheses enabled us to examine whether a potential interaction effect was limited to particular dimensions of personal epistemology, as was the case in the Bråten and Strømsø (in press) study. Covariates in every analysis were topic knowledge and topic interest.

Next, we performed four separate 2 x 2 ANCOVAs on each of the three writing task measures (i.e., the transformation measure and the two integration measures), using the same independent variables and covariates.

Table 3. 2

Participants' Distribution on Epistemology Groups and Task Condition

Dimension	Group	Condition	
		Summary	Argument essay
Certainty-T	Naïve	9	15
	Sophisticated	16	13
Certainty-A	Naïve	13	13
	Sophisticated	12	15
Source beliefs	Naïve	12	11
	Sophisticated	13	17
Justification beliefs	Naïve	12	12
	Sophisticated	13	16

Note. Certainty-T = Certainty—Tentativeness, Certainty-A = Certainty—Ambiguity.

Participants' distribution on epistemology groups and conditions is shown in Table 3.2. A series of *t*-tests were performed to verify that the epistemology groups differed on the specific dimensions. Results revealed statistically significant differences between the "naïve" versus "sophisticated" groups on each of the four belief dimensions. Thus, on the certainty—tentativeness dimension the naïve group (M = 4.92, SD = 0.82) had statistically significantly lower scores than the sophisticated group (M = 7.33, SD = 1.04), $t(51) = -9.21$, $p = .000$; as they had on the certainty—ambiguity dimension (M = 5.13, SD = 0.67, for the naïve group; M = 6.98, SD = 0.71, for the

sophisticated group; $t(51) = -9.75$, $p = .000$), on the source dimension ($M = 4.54$, $SD = 0.80$, for the naïve group; $M = 6.59$, $SD = 0.80$, for the sophisticated group; $t(51) = -9.10$, $p = .000$), and on the justification dimension ($M = 6.34$, $SD = 0.80$, for the naïve group; $M = 8.01$, $SD = 0.71$, for the sophisticated group; $t(51) = -8.06$, $p = .000$). The means and the standard deviations of the covariates for each group are shown in Table 3.3. In general, participants holding sophisticated epistemological beliefs seemed to have somewhat higher topic knowledge and topic interest than participants holding naïve beliefs, with an exception to this being students classified as sophisticated and naïve on the certainty—ambiguity dimension who were in the summary condition. It should also be noted that while students in the summary condition seemed to score somewhat higher than students in the argument condition with respect to topic knowledge, students in the argument condition reported on somewhat higher interest in the topic. As can be seen in Table 3. 3, interest in the topic was particularly high among students holding sophisticated beliefs on the justification dimension.

Table 3.3

Means and Standard Deviations of Topic Knowledge and Topic Interest for All Groups

		Condition							
		Summary				Argument essay			
		Topic knowledge		Topic interest		Topic knowledge		Topic interest	
Dimension	Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Certainty-T	Naïve	5.44	1.7	70.56	19.9	5.07	2.6	75.40	20.8
	Sophisticated	6.50	2.0	72.68	21.5	5.53	2.7	74.92	21.3
Certainty-A	Naïve	6.54	1.8	75.61	23.7	4.92	1.9	74.54	14.1
	Sophisticated	5.67	2.1	67.92	16.5	5.60	3.1	75.73	25.6
Source beliefs	Naïve	6.17	1.9	70.08	18.2	5.27	2.4	75.27	21.0
	Sophisticated	6.36	2.0	76.64	23.5	5.29	2.8	75.12	21.1
Justification beliefs	Naïve	5.25	1.7	62.33	16.4	5.42	3.3	65.75	15.7
	Sophisticated	6.92	1.8	80.77	20.5	5.19	2.0	82.25	21.5
	Total	6.12	1.9	71.92	20.5	5.28	2.6	75.17	20.6

Note. Certainty-T = Certainty—Tentativeness, Certainty-A = Certainty—Ambiguity.

Text Understanding Measures

Means and standard deviations for each group on the three text understanding measures are presented in Table 3. 4.

Table 3. 4

Means and Standard Deviations of Text Understanding Measures for Epistemology Groups by Task Condition

		Condition											
		Summary						Argument essay					
		SVT		IntraVT		InterVT		SVT		IntraVT		InterVT	
Dimension	Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Certainty-T	Naïve	23.44	3.5	17.44	4.2	15.44	3.4	21.07	5.6	14.07	5.4	13.20	5.3
	Sophisticated	24.44	3.3	16.25	2.5	16.19	2.5	19.61	5.8	13.61	3.6	12.92	4.5
	Total	24.08	3.3	16.68	3.2	15.92	2.8	20.39	5.6	13.86	4.6	3.07	4.8
Certainty-A	Naïve	23.77	3.3	18.08	3.2	16.00	2.5	19.54	6.0	12.31	4.3	12.77	4.7
	Sophisticated	24.42	3.4	15.17	2.5	15.83	3.2	21.13	5.4	15.20	4.5	13.33	5.1
	Total	24.08	3.3	16.68	3.2	15.92	2.8	20.39	5.6	13.86	4.6	13.07	4.8
Source beliefs	Naïve	24.42	2.6	17.08	3.7	15.83	3.2	18.64	4.8	13.09	4.7	13.09	5.1
	Sophisticated	23.54	4.2	16.27	3.0	15.73	2.6	21.53	6.0	14.35	4.6	13.06	4.9
	Total	24.00	3.4	16.69	3.3	15.78	2.9	20.39	5.6	13.86	4.6	13.07	4.8
Justification beliefs	Naïve	22.75	2.9	16.41	2.5	16.42	3.0	19.50	6.8	12.92	5.3	12.33	6.3
	Sophisticated	25.31	3.3	16.92	3.8	15.46	2.6	21.06	4.7	14.56	4.0	13.62	3.5
	Total	24.08	3.3	16.68	3.21	15.92	2.8	20.39	5.6	13.85	4.6	13.07	4.8

Note. Certainty-T = Certainty—Tentativeness, Certainty-A = Certainty—Ambiguity. SVT = Sentence verification task, IntraVT = Intratextual inference verification task, InterVT = Intertextual inference verification task

.

The ANCOVAs with certainty of knowledge—tentativeness (naïve and sophisticated) and task (argument and summary) as independent variables yielded a statistically significant main effect of task on each of the three dependent measures after adjustment by covariates. Specifically, results showed that students in the summary condition performed better on the SVT than students in the argument essay condition, $F(1, 52) = 6.957$, $p < .05$, partial $\eta^2 = .129$. Likewise, students who were reading in order to write a summary performed better on the IntraVT, $F(1, 52) = 6.906$, $p < .05$, partial $\eta^2 = .128$, and on the InterVT, $F(1, 52) = 4.197$, $p < .05$, partial $\eta^2 = .082$, than participants who were reading in order to write an argument essay.

The covariate of topic knowledge adjusted only scores on the InterVT, $F(1, 53) = 4.242$, $p < .05$, partial $\eta^2 = .083$, with this indicating that high-knowledge participants performed better on this dependent measure than low-knowledge participants. Neither the main effect of certainty of knowledge—tentativeness nor the interaction between scores on this belief dimension and task were significant.

In the second set of ANCOVAs, using certainty of knowledge—ambiguity and task as independent variables, dependent variables were again the three understanding measures. Again, after adjustment by covariates, scores on the SVT, $F(1, 52) = 7.575$, $p < .01$, partial $\eta^2 = .139$, IntraVT, $F(1, 52) = 7.183$, $p < .01$, partial $\eta^2 = .133$, and InterVT, $F(1, 52) = 4.328$, $p < .05$, partial $\eta^2 = .084$, varied statistically significantly with task. That is, students in the summary condition outperformed the students in the argument condition on all three understanding measures. Like in the analyses with certainty of knowledge—tentativeness as an independent variable, the covariate of topic knowledge adjusted only scores on the InterVT, $F(1, 53) = 4.222$, $p < .05$, partial $\eta^2 = .082$, indicating better intertextual understanding for the high-knowledge participants. No statistically significant main effect of certainty of knowledge—ambiguity was found. However, one interaction effect between task and

certainty of knowledge—ambiguity was found on the IntraVT, $F(1, 53) = 6{,}060$, $p < .05$, partial $\eta^2 = .114$. This interaction is graphed in Figure 3.1.

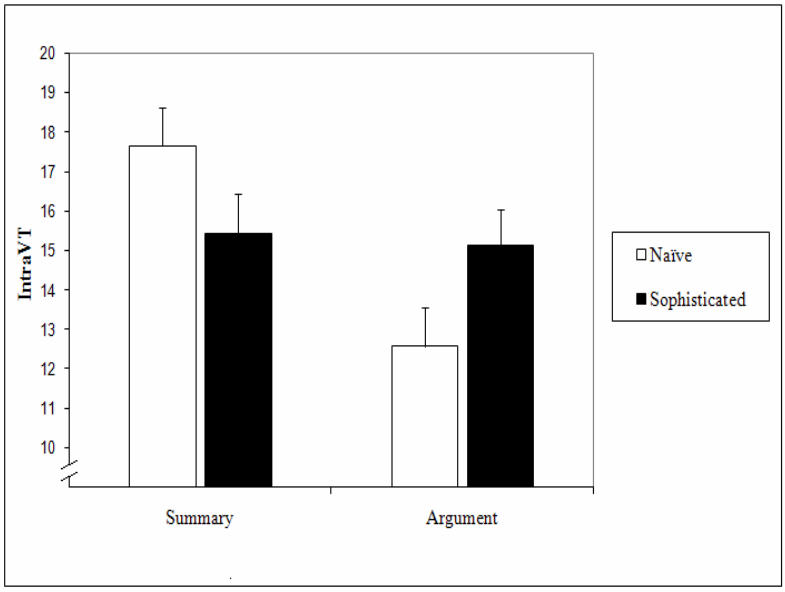

Figure 3.1. Interaction effect between certainty of knowledge—ambiguity beliefs and task on intratextual inference verification (IntraVT). Error bars represent standard errors.

As can be seen, participants holding naïve certainty beliefs (believing that knowledge about climate change is unambiguous and unconditional) gained better intratextual understanding in the summary condition than in the argument condition, whereas students holding sophisticated certainty beliefs (believing that knowledge about climate change is ambiguous and conditional) achieved a similar level of intratextual understanding in both condition. We will return to this interesting interaction in the discussion.

The third set of ANCOVAs was performed with the independent variables of source of knowledge and task. After adjustment by covariates, scores on the SVT, $F(1, 52) = 4.222$, $p < .05$, partial $\eta^2 = .082$, and the IntraVT, $F(1, 52) = 7.575$, $p < .01$,varied statistically significantly with task, indicating a facilitative effect of the summary condition. However, in this set of analyses, the main effect of task on InterVT-scores

did not quite reach a conventional level of statistical significance, $F(1, 52) = 3.14$, $p = .083$, partial $\eta^2 = .065$. The covariate of topic knowledge adjusted scores on the InterVT, $F(1, 53) = 4.441$, $p < .05$, partial $\eta^2 = .090$, indicating that high-knowledge participants performed better on this dependent measure. Neither the main effect of source of knowledge nor the interaction between scores on this belief dimension and task were statistically significant.

Finally, ANCOVAs were performed with the independent variables of justification for knowing and task. Again, there were statistically significant main effects of task on all three understanding measures after adjustment by covariates, showing that students in the summary condition scored better on the SVT, $F(1, 52) = 6.957$, $p < .05$, partial $\eta^2 = .129$, the IntraVT, $F(1, 52) = 6.906$, $p < .05$, partial $\eta^2 = .128$, and the InterVT, $F(1, 52) = 4.197$, $p < .05$, partial $\eta^2 = .082$, than students in the argument condition. As in the previous analyses, the covariate of topic knowledge adjusted the InterVT-scores, $F(1,53) = 4.242$, $p < .05$, partial $\eta^2 = .083$, and neither the main effect of justification for knowing nor the interaction between this dimension and task were statistically significant.

Writing Task Measures

Means and standard deviations for the three writing task measures for all groups are presented in Table 3.5, while Table 3.6 summarizes the statistical information for the four separate ANCOVAs with one of the four dimensions of topic-specific epistemological beliefs (naïve and sophisticated) and task (argument and summary) as independent variables on each of the three writing task measures.

Table 3. 5

Means and Standard Deviations of Writing Measures for Epistemology Groups by Task Condition

		Condition											
		Summary						Argument essay					
		Trans		*n* texts		*n* switches		Trans		*n* texts		*n* switches	
Dimension	Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Certainty-T	Naïve	21.22	3.4	5.22	0.8	5.00	1.4	17.06	9.2	4.33	3.5	3.73	2.8
	Sophisticated	20.06	4.4	4.75	2.4	5.93	1.2	15.46	6.0	3.00	1.9	4.07	2.2
	Total	20.45	4.0	4.92	1.9	5.60	1.3	16.32	7.9	3.71	2.9	3.89	2.5
Certainty-A	Naïve	20.69	3.2	4.84	1.9	5.8	1.5	15.00	6.5	3.76	3.9	3.23	2.1
	Sophisticated	20.25	4.9	5.00	2.1	5.83	1.2	17.46	8.8	3.66	1.8	4.46	2.8
	Total	20.48	4.0	4.92	1.9	5.60	1.3	16.32	7.8	3.71	2.9	3.89	2.5
Source beliefs	Naïve	19.41	4.5	5.41	1.7	5.50	1.4	15.90	8.0	3.27	1.9	4.00	2.8
	Sophisticated	21.27	3.7	4.27	2.2	5.90	1.4	16.58	7.9	4.00	3.4	3.82	2.4
	Total	20.30	4.1	4.86	2.0	5.69	1.4	16.32	7.9	3.71	2.9	3.89	2.5
Justification beliefs	Naïve	20.91	4.1	5.25	1.5	5.75	1.4	14.50	6.3	4.00	3.9	3.83	2.1
	Sophisticated	20.07	4.0	4.61	2.3	5.46	1.3	17.68	8.8	3.50	2.1	3.93	2.3
	Total	20.48	4.0	4.92	1.9	5.60	1.3	16.32	7.8	3.71	2.9	3.89	2.2

Note. Certainty-T = Certainty—Tentativeness, Certainty-A = Certainty—Ambiguity.Trans = overall content transformation, *n* texts = number of texts used, *n* switches = number of switches between sources.

Table 3. 6
Analyses of Covariance for Writing Measures Showing Main Effects of Task

ANCOVA	Dependent measure	*F*	partial η^2	*p*
Certainty-T & Task				
	Transformation	*F*(1, 52) = 5.298*	.101	.03
	n texts	*F*(1, 52) = 3.410	.068	.07
	n switches	*F*(1, 52) = 6,696*	.125	.01
Certainty-A & Task				
	Transformation	*F*(1, 52) = 5.254*	.101	.03
	n texts	*F*(1, 52) = 3.085	.062	.08
	n switches	*F*(1, 52) = 9.016**	.161	.00
Source beliefs & Task				
	Transformation	*F*(1, 52) = 4.017	.082	.05
	n texts	*F*(1, 52) = 3.160	.066	.08
	n switches	*F*(1, 52) = 8.457**	.158	.00
Justification beliefs & Task				
	Transformation	*F*(1, 52) = 5,144*	.099	.03
	n texts	*F*(1, 52) = 3.143	.063	.08
	n switches	*F*(1, 52) = 7.185**	.142	.00

Note. Certainty-T = Certainty—Tentativeness, Certainty-A = Certainty—Ambiguity. *n* texts = number of texts used, *n* switches = number of switches between sources.

*$p < .05$, **$p < .01$

Transformation. As can be seen in Table 3.6, all four ANCOVAs indicated statistically significant main effects of task on the measure of overall content transformation, with students in the summary condition displaying a greater degree of transformation in their writings than did students in the argument essay condition. In no analysis was the main effect of topic-specific epistemological beliefs or the interaction between epistemological beliefs and task statistically significant.

Integration. As can also be seen in Table 3.6, the four ANCOVAs suggested a trend towards students in the summary condition using a greater number of different texts in their writings than those in the argument condition. However, the main effects of task did not quite reach statistical significance in any of these analyses. With respect to the merging of information, indicated by the number of switches between sources in student summaries or argument essays, all four ANCOVAs showed a statistically

significant effect of task, with students in the summary condition producing a greater number of switches between sources than students in the argument condition. There were also no main effects of topic-specific epistemological beliefs or interactions between beliefs and task in any of the analyses concerning integration.

Correlational Analysis

To complete our analyses, simple correlations among covariates, topic-specific epistemological beliefs, and dependent measures were examined (see Table 3. 7).

Table 3.7

Zero-Order Correlations for All Variables

	1	2	3	4	5	6	7	8	9	10	11	12
1.Topic knowledge	-											
2. Topic interest	58**	-										
3. Certainty-T	.26	-.04	-									
4. Certainty-A	.19	.15	.03	-								
5. Source beliefs	.07	.02	.03	.17	-							
6. Justification	.19	50**	.14	.07	.18	-						
7. SVT	40**	.29*	.04	.19	.17	.16	-					
8. IntraVT	45**	.35*	-.04	.14	.04	.17	67**	-				
9. InterVT	39**	.17	.18	.03	-.08	.14	59**	58**	-			
10. Transformation	.22	.16	.03	.03	.13	-.05	36**	.23	.27*	-		
11. *n* texts	-.14	-.18	-.19	-.19	.04	-.19	.32*	.27*	.08	37**	-	
12. *n* switches	-.11	.32*	.13	.13	.03	-.01	.07	.15	.13	.27*	.4**	-

Note. Certainty-T = Certainty—Tentativeness, Certainty-A = Certainty—Ambiguity. SVT = Sentence verification task, IntraVT = Intratextual inference verification task, InterVT = Intertextual inference verification task. *n* texts = number of texts used, *n* switches = number of switches between sources.
*$p < .05$, **$p < .01$

Several correlations are noteworthy. Topic knowledge was positively related to the three text understanding measures, indicating that high-knowledge participants were more likely to gain superficial as well as within- and across-text deep-level understandings than were low-knowledge participants. Additionally, topic interest was positively related to the two measures targeting understanding of single texts, that is, the SVT and the IntraVT. Participants' topic-specific epistemological beliefs were not associated with any text understanding or writing measure or with each other. This result supports the notion of personal epistemology as a system of more or less independent beliefs (Schommer, 1990). Finally, there were positive intercorrelations within and across the two kinds of dependent measures (i.e., the text understanding measures and writing task measures), with those intercorrelations supporting the validity of our dependent measures.

3.4. DISCUSSION

In this study, we examined the effect of two tasks, summaries and argument essays, on students' comprehension and integration of multiple documents. Additionally, we examined whether the effect of task may be dependent on students' personal epistemology concerning the topic of reading.

We hypothesized that the argument essay task would facilitate a deeper and more integrated text understanding than the summary task. However, somewhat surprisingly, our results showed that students in the summary condition outperformed students in the argument condition with respect to both the text understanding measures and the writing task measures. More specifically, participants who read the texts in order to write a summary obtained higher scores on the understanding measures developed to assess memory for text, deeper understanding of each single text, and the ability to draw inferences across texts, respectively. Likewise, in their compositions, participants in the summary condition produced more transformations,

covered the text materials more completely, and merged information from the different sources to a larger extent than did students in the argument essay condition.

Thus, our study showed a consistent result pattern across dependent measures that seems out of step with prior research on multiple-texts comprehension (Wiley & Voss, 1999; Le Bigot & Rouet, 2007). For example, Wiley and Voss found that students who wrote arguments performed better on an inference verification task and produced essays with more transformation and integration. In line with this, Le Bigot and Rouet showed that participants who were assigned an argument task wrote essays that contained more transformed information than participants who were assigned a summary task. At the same time, there are also some other recent findings (Bråten & Strømsø, in press; Le Bigot & Rouet, 2007) speaking against a generally facilitative effect of argument tasks. In the Bråten and Strømsø (in press) study, for example, students who read multiple texts about climate change in order to write a summary performed equally well on a deep-level comprehension measure as students who read the same texts in order to write an argument essay. Likewise, Le Bigot and Rouet (2007) did not find that the argument task led to better performance on a comprehension questionnaire. Those findings suggest, as do the findings of the current experiment, that argument tasks are not always optimal for promoting comprehension and integration. One possible reason for this might be that the effect of task condition depends on individual characteristics of the readers.

One such characteristic examined in our experiment was students' personal epistemology concerning the topic of the texts. Our hypothesis was that the argument condition could be more beneficial to readers holding sophisticated epistemological beliefs than to those holding naïve beliefs. This hypothesis gained only limited support from our experiment, however. Thus, in only one analysis, including students sophisticated and naïve with respect to certainty of knowledge—ambiguity beliefs and using the intratextual inference verification task as dependent measure, did the effect

of task condition seem to be moderated by readers' epistemological beliefs concerning the topic. Specifically, readers with naïve beliefs, holding that knowledge about the topic consists of unambiguous and unconditional truths, were particularly hindered by the argument condition when constructing meaning within texts, whereas readers with sophisticated beliefs, holding that knowledge about the topic is ambiguous and conditional, performed equally well in the two conditions. Apparently, readers holding sophisticated beliefs on this dimension were less constrained by the challenging argument task than were naïve readers, possibly because their belief in ambiguous and conditional knowledge better equipped them to flexibly adapt their approach to the task condition. Accordingly, Pieschl et al. (2008) recently found that students who believed in complex knowledge were more able to self-regulate their learning in relation to task demands and gained more knowledge when studying multiple documents on a particular scientific topic than students holding naïve epistemological beliefs. Because the described interaction effect was observed for only one of our dependent measures, however, it should be interpreted with great caution. Still, the fact that it corroborates prior work by Bråten and Strømsø (in press) may give some credence to our finding on this point. Thus, Bråten and Strømsø (in press) also found that effects of task depended on participants' certainty beliefs, with participants characterized by more sophisticated beliefs more able to profit from the argument task than were participants characterized by more naive beliefs. That said, much further work is definitely needed to clarify whether and how personal epistemology may interact with task condition in determining the comprehension and integration of multiple documents.

Topic knowledge is, presumably, another individual characteristic of crucial importance when reading multiple documents. In our study, topic knowledge was positively related to all our comprehension measures and, at the same time, uniquely adjusted scores on the intertextual inference verification task. It is possible that the beneficial effects of the summary condition that we observed in the current research

are due to the generally low level of topic knowledge among our participants (see Table 3.3). While there was no information about participants' background knowledge included in the Wiley and Voss (1999) study, the participants in the Le Bigot and Rouet (2007) study seemed to be more knowledgeable about the topic of the texts than were the participants in the current research. There might thus have been a mismatch between the level of topic knowledge characterizing our participants and the challenging task of having to construct arguments from complex scientific texts. This possibility is supported by previous research demonstrating that low-knowledge students do not fare as well in demanding task conditions as they do in more easy ones (McNamara at al., 1996). Moreover, McNamara (2001, 2004) found that reading strategy instruction only facilitated low-knowledge participants' performance on text-based comprehension questions and not on bridging-inference questions, indicating that without sufficient knowledge, readers have difficulties linking distant pieces of information and drawing knowledge-based inferences. Moos and Azevedo (2008) demonstrated, accordingly, that good prior knowledge may be needed to draw inferences and use metacognitive processes (i.e., monitoring and planning) productively during multiple-documents reading. In that study, low-knowledge students tended to rely on a few, specific strategies such as note taking and summarizing during reading. Given our results, it is conceivable, though, that some sophisticated epistemological beliefs may function as a bulwark against the detrimental effects of tasks overtaxing readers' current knowledge level, such as the argument task, possibly by promoting some of the self-regulatory processes that high-knowledge readers are more likely to use.

Further research could test whether more knowledgeable students are actually more able to take on the complex task of constructing arguments from texts by providing some students with relevant topic knowledge before reading and then comparing their performance to that of students not given such instruction. Moreover,

the potentially compensatory effect of holding sophisticated epistemological beliefs for low-knowledge participants should be further researched.

It should be noted that results were consistent across the three verification tasks that we used as dependent measures even though they were designed to assess different aspects of text understanding. Specifically, the SVT was modelled after Royer et al. (1996) to assess memory for factual information rather than inferential understanding. However, it should be noted that the SVT was administered after the reading of all seven documents and without permission to look back to the documents while answering the questions. It is therefore conceivable that participants found it so hard to remember specifically which meanings were included in the documents that this task actually measured inferencing and as much as it measured remembering. The correlation between topic knowledge and SVT-scores, as well as between scores on the three text understanding measures, also suggests that the SVT was not a pure measure of factual understanding (cf., Strømsø, Bråten, & Samuelstuen, 2007). This may explain the consistency of results across understanding measures observed in this study.

Another possible explanation for the benefits of the summary condition that we observed in this study is related to the complexity of the scientific topic and the textual sources dealing with it (i.e., seven different documents containing partly contradictory information). Thus, the summary task may have made students pay closer attention to the contents presented in the different documents with this, in turn, helping them to build more accurate and integrated representations. In contrast, the emphasis put on personal opinion in the instruction for the argument condition may have made students think that they could get away with disregarding what was in the texts themselves and rely more on making weakly founded assumptions. Several other studies also indicate that summarizing information when reading may foster comprehension and learning by securing an accurate representation of text content (Bransford et al, 2000; Wade-Stein

& Kintsch, 2004). Ideally, summarizing during reading not only involves selecting and memorizing ideas from text for later knowledge-telling, but also an active, knowledge-transforming interaction with the text content (cf., Bereiter & Scardamalia, 1987). In this study, the instruction to construct an elaborative summary of the most relevant information may also have contributed to the general superiority of the summary condition. However, only further experimentation using topics and texts varying with respect to complexity, as well as different types of summary instructions, can empirically clarify these issues. Moreover, future researchers might consider varying not only summary instructions but also the instructions given in order to promote the construction of arguments. For example, just asking readers to write a brief report where they express and justify their personal opinion, as we did in the current study, may not have communicated clearly enough what the participants were supposed to do.

An additional reason why our participants were hindered rather than helped by the argument task may be that in the Spanish educational system, most students have very limited experience writing argument essays. It is therefore possible that some form of direct instruction in how to write arguments may be needed to improve the performance of Spanish students in this task condition (cf., Britt & Aglinskas, 2002). Without such instruction, teachers should be aware that argument tasks are not always beneficial for learning. In particular, low-knowledge readers may become cognitively overwhelmed when faced with the difficult task of integrating information and constructing defensible and well-grounded arguments, with this, in turn, reducing their possibilities of learning the content. An alternative may therefore be that these readers start the process of learning from multiple texts with less demanding tasks, such as summaries, and that they are not confronted with argument tasks until they have acquired the necessary knowledge base to handle them.

CAPÍTULO 4

Summary versus Argument Tasks when Working with Multiple Documents: Which is Better for Whom?

ABSTRACT

This article reports on two experiments where undergraduates read seven documents on a scientific topic and afterwards answered comprehension questions and wrote either summaries or argument essays on the topic. In the first experiment, students who were instructed to work with the documents for the purpose of summarizing their contents displayed better comprehension and integration of document contents than did students instructed to construct arguments from the documents. In the second experiment, focusing on whether the effects of task instructions on multiple-documents comprehension and integration could be moderated by students' prior knowledge about the topic of reading, it was found that only students with high prior knowledge were able to take advantage of instructions to construct arguments while reading, whereas low knowledge readers seemed to be more hindered than helped by such task instructions. Theoretical as well as educational implications of these findings are discussed.

INTRODUCTION

According to Goldman (2004), one of the most critical challenges for a knowledge society may be to cultivate human capital that can comprehend and integrate multiple, varied, and prolific information sources. To meet that challenge, students must be given opportunities to work with multiple documents and learn how to compare, contrast, and relate them (Rouet, 2006). Recent studies have suggested that some multiple-documents tasks are more suitable for promoting deeper and more integrated understanding than others (e.g., Britt & Sommer, 2004; Bråten & Strømsø, in press; Cerdán & Vidal-Abarca, 2008; Gil, Bråten, Vidal-Abarca, & Strømsø, in press; Le Bigot & Rouet, 2007; Wiley & Voss, 1999). Given inconsistent findings regarding which tasks may facilitate or constrain multiple-documents comprehension, however (see below), there is still room for increased clarity concerning this important issue. In particular, this paper focuses on the effect of two specific multiple-document tasks, summaries and argument essays, on the comprehension and integration of multiple expository texts about a scientific topic. We thus report on two experiments that were designed to clarify previous conflicting findings regarding the effects of those two tasks, examining whether the effect of summaries and arguments essays may be dependent on some characteristic of the learning situation (Experiment 1) or on some characteristic of the reader (Experiment 2).

Multiple-Documents Literacy

Multiple-documents literacy concerns de ability to locate, evaluate, and use diverse sources of information for the purpose of constructing and communicating an integrated, meaningful representation of a particular issue, subject or situation (Bråten & Strømsø, 2008). This type of literacy is increasingly required in both classrooms and other learning contexts, with students as well as other citizens often learning about different topics from multiple sources containing supporting, complementary, or opposing information. In the last decade, it has been shown that reading about a controversial topic in multiple source documents rather than a single textbook presenting the same content may facilitate deep-level, integrated comprehension (e.g. Britt & Aglinskas, 2002; Bråten & Strømsø, 2006a; Nokes, Dole, & Hacker, 2007; Wiley & Voss, 1999). Such findings may be explained within the framework of the "cognitive flexibility theory" of Spiro and colleagues (e.g., Spiro, Feltovich, Jacobson, & Coulson, 1991; Spiro, Coulson, Feltovich, & Anderson, 1994), where gaining a rich and flexible understanding of a complex knowledge domain is said to require a "criss-crossing" of it from multiple intellectual perspectives. In that theory, contrasting perspectives located in multiple sources may highlight the interrelated and web-like nature of knowledge and encourage readers to assemble knowledge components for application in new situations. However, despite the important finding that reading multiple documents may allow readers to construct a deeper and more interconnected understanding than just reading the textbook, our understanding of how multiple-document literacy can be effectively promoted as part of normal teaching is still very limited (Schwarz, 2003), and many students, even at the college level, seem to have little guided experience in learning from multiple documents. Spontaneously, students more often than not seem to have great difficulties coping with this complex activity.

For example, since Wineburg's (1991) classic study, showing that high-school students reading multiple documents seldom used the "sourcing", "corroboration", and

"contextualization" heuristics heavily relied on by historians, quite a few other studies have shown that without some specific instruction, the multiple-documents literacy of students ranging from elementary (VanSledright & Kelly, 1998) to secondary school students (Britt & Aglinskas, 2002; Stahl, Hynd, Britton, McNish, & Bosquet, 1996) and undergraduates (Perfetti, Britt, & Georgi, 1995; Rouet, Favart, Britt, & Perfetti, 1997) leaves much to be desired. While the "sourcing heuristic" observed among experts involves an attention the source of each document to determine its evidentiary value, "corroboration" involves a systematic comparison of content across documents to examine potential contradictions or discrepancies among them, and "contextualization" involves using prior knowledge to situate document information in a broad spatial-temporal context. Through a strategic approach composed of these three heuristics, the historians in Wineburg's (1991) study tried to piece together a coherent interpretation of the event described in the documents, at the same time paying close attention to the different sources on which this interpretation was based. While some efforts to train students' ability to strategically handle multiple documents have focused on exposing them to multiple textual sources while externalizing construction and integration processes in the classroom (e.g., Goldman & Bloome, 2004; Nokes et al., 2007; VanSledright, 2002), others (e.g., Britt & Aglinskas, 2002; Britt, Wiemer-Hastings, Larson, & Perfetti, 2004) have focused on computer-based training. Our main assumption in the present study is that an important aspect of trying to improve students' multiple-documents literacy concerns the assignment of tasks that may actually facilitate their comprehension and integration across sources.

Multiple-Documents Tasks

Recently, researchers have started to investigate which learning tasks may facilitate students' multiple-documents literacy by promoting a deeper and more integrated comprehension of texts (Britt & Sommer, 2004; Bråten & Strømsø, in press; Le Bigot & Rouet, 2007; Cerdán & Vidal-Abarca, 2008; Kobayashi, in press; Naumann,

Wechsung, & Krems, in press; Schwarz, 2003; Wiley & Voss, 1999). Two tasks that have been focused in that work are instructing students to work with documents for the purpose of summarizing their contents and instructing them to construct arguments based on document contents. However, only a few studies exist that directly compare the effects of summary and argument tasks on multiple-documents comprehension and integration, with those studies showing somewhat inconclusive findings (Bråten & Strømsø, in press; Gil et al., in press; Le Bigot & Rouet, 2007; Wiley & Voss, 1999). On the one hand, beneficial effects of argument tasks have been demonstrated for several learning measures, such as deep understanding and transformation in student writings. Thus, Wiley and Voss (1999) found that students who wrote arguments from multiple texts concerning the history of Ireland gained deeper and more integrated understanding of the historical event than did students who wrote summaries. Moreover, they found that students who read in order to write arguments produced more integrated and transformed essays than did students who read the same texts in order to write summaries. Accordingly, Le Bigot and Rouet (2007) found that students instructed to write arguments based on texts about different aspects of social influence produced essays with more transformed information than did students instructed to write summaries about the same topic.

On the other hand, there are some findings not showing any significant differences between students reading multiple texts in order to construct arguments and students reading in order to summarize information. First, in the Le Bigot and Rouet (2007) study, it was found that students in the argument task condition performed equally well on a comprehension questionnaire as did students in the summary condition. Second, Bråten and Strømsø (in press) found that students reading multiple texts about climate change in order to construct arguments or summarize information gained better understanding than those reading to produce a

general overview, but no difference was found between students reading to construct arguments and those reading to summarize the content of the texts.

Finally, Gil et al. (in press) recently presented evidence that summary tasks in some instances may be even more facilitative than argument tasks. Somewhat surprisingly, they found that participants who wrote summaries after reading seven texts about climate change obtained higher scores on measures of both superficial and deep comprehension than those who wrote argument essays. Moreover, in their writings, participants in the summary condition produced more transformations, covered the text materials more completely, and merged information from the different sources to a larger extent than did participants in the argument condition. It should be noted that these differences between task conditions were obtained after scores on the reading and writing measures were adjusted for the covariate of prior knowledge.

Gil et al. (in press) discussed several possible explanations for their findings, focusing on the possibility that the effect of task condition depended on individual characteristics of the readers. An additional explanation, not elaborated upon by Gil et al., might be that students were allowed just 50 minutes to read seven complex texts on a science topic and perform a writing task, with this allowing for too little time to read and comprehend the contents of the document set while also constructing their own arguments and stating their own opinions about the complex issue. Consequentially, readers in the argument condition had to settle for or adopt a more superficial processing of text information and, therefore, were not able to take advantage of a task condition that may otherwise be beneficial because it can promote deep-level processing (Bereiter & Scardamalia, 1987; Wiley & Voss, 1999). Another possibility might be that students read the seven texts and wrote summaries or argument essays on a laptop using an unfamiliar software, with this, also, being more detrimental in the challenging argument condition than in the more manageable summary condition because of cognitive overload.

With respect to reader characteristics, Gil et al. (in press) found only limited support for their hypothesis that personal epistemology concerning the topic of the texts might moderate the effect of task condition on multiple-text comprehension and integration. However, in their discussion they highlighted the possibility that, given the generally low level of topic knowledge among their participants, the advantage of the summary condition that they observed might have been due to a mismatch between the level of topic knowledge and the challenging task of having to construct arguments from complex scientific texts. Consequentially, Gil et al. (in press) called for further research to test whether more knowledgeable students are actually more able to take on the complex task of constructing arguments from texts by providing some students with relevant topic knowledge before reading and then comparing their performance to that of students not given such instruction.

Building on the Gil et al. (in press) study, we designed two new experiments to investigate whether reading amount and reading environment, as well as topic knowledge, could actually explain their findings regarding the lack of benefit of the argument task on multiple-text comprehension and integration. In the first experiment, we reduced the number of texts and allowed some of the participants to study the documents in a more familiar reading environment. In the second experiment, we tested whether the facilitative effect of the argument task on multiple-text comprehension and integration would be limited to students with high prior knowledge about the topic of the texts.

4.1. EXPERIMENT 1

Comprehension and integration of multiple texts have been shown to involve considerable strategic effort, such as the sourcing, corroboration, and contextualization heuristics observed by Wineburg (1991), and the causal and comparative cross-text self-explanations observed by Wolfe and Goldman (2005). Recently, Afflerbach and

Cho (in press) identified the strategy categories of “identifying and learning important information”, “monitoring”, and “evaluation” as involved in the reading of multiple texts (see also, Bråten & Strømsø, 2003, 2006b; Strømsø, Bråten, & Samuelstuen, 2003). Assuming that the time-limit set for the argument task in our previous experiment (Gil et al., in press) might not have permitted participants to execute the strategic processing required to comprehend and integrate text information while, at the same time, constructing their own arguments and stating their own opinions about the complex issue, reducing the workload and thereby providing readers with more time to complete the argument task could help them reap the potential benefits of this demanding task condition.

Moreover, Gil et al. (in press) had participants read texts and afterwards perform writing tasks on a laptop using unfamiliar software. This software presented readers with a full screen of masked linear text preserving the spatial identity of text sentences, and they had to click on the segment that they wanted to read in order to unmask it. Several studies have found differences between reading digital and conventional printed texts. For example, Murphy, Long, Holleran, and Esterly (2003) showed that students who read two texts in a linear computerized format found the texts significantly more difficult to understand and less interesting than did students who read the same texts in a traditional pencil-and-paper format. Murphy et al. suggested that students might fail to transfer their repertoire of strategies to comprehend and remember printed texts to computerized texts, or, alternatively, that the strategies required to comprehend printed texts are not exactly the same as those required to comprehend computerized texts. Other researchers (Landauer, 1996; Nielsen, 2000) have found that reading text on a computer screen is perceptually more difficult and slower than reading on paper, suggesting that some of the basic difficulties with reading on a computer screen may relate to perceptual difficulties and consequent disorientation. Because students are increasingly reading digital texts, however, they

may well have become more proficient in handling the challenges that these kinds of texts previously seemed to represent.

Also, some early studies (McKnight, Dillon, & Richardson, 1990; Muter & Maurutto, 1991) comparing reading on a screen and reading on paper did not find differences between the conditions in regard to reading speed and comprehension. Reading on a computer screen and successively having to unmask small segments of multiple texts when trying to comprehend and integrate information from those texts may, however, present new challenges to readers that could be especially problematic in the demanding task condition of constructing arguments and expressing their own opinion about what they read. It is conceivable, for example, that the unfamiliar masking and unmasking procedure of such an environment may constrain the extensive intertextual or cross-text strategic processing required to succeed on this task.

4. 1. 1. OBJECTIVES AND HYPOTHESES

The purpose of this experiment was twofold. First, we wanted to compare the effects of summary and argument essay tasks on students' comprehension and integration of multiple documents about the topic of climate change with reduced workload and, thereby, more time available to study the documents than in our previous experiment (Gil et al., in press). Therefore, we kept a time-limit of 50 minutes for completing the tasks but reduced the number of texts from seven to five. On the basis of prior research reviewed above (Le Bigot & Rouet, 2007; Wiley & Voss, 1999), we hypothesized that students in the argument condition would outperform students in the summary condition. This is because an argument task has been shown to promote the elaboration, transformation, and integration of relevant text content to a greater extent than a summary task, and because we thought that the students in this experiment would work with a document set more adjusted to the time available for the effortful and complex processing presumably required by the argument task.

Second, we wanted to examine whether the effect of task was dependent on the mode of presentation, specifically, comparing students reading and performing writing tasks in a traditional paper-and-pencil environment with students reading the same texts and given the same writing tasks in the unfamiliar computer-based environment used in our previous experiment (Gil et al., in press). As suggested above, this computer-based environment could be especially problematic for students in a demanding task condition where they are asked to construct arguments and express their own opinion about what they read. At the same time, students in the more familiar paper-and-pencil environment could be better able to take advantage of the challenging task of expressing and justifying their personal opinion, for example, because this task condition could make it easier for them to perform the cross-text processing of content necessary to compare and integrate explanations and arguments across texts. In that case, students in the argument condition could be expected to outperform students in the summary condition in the paper-and-pencil environment but not necessarily in the computer-based environment that we designed, with this resulting in an interaction effect of task condition with mode of presentation on multiple-text comprehension and integration. Alternatively, another possibility is that the adjustment that we made to participants' workload in this experiment could compensate for the potentially detrimental effect of the unfamiliar reading environment on performance in the argument condition.. If this is the case, no interaction between task condition and mode of presentation would appear.

As in the previous experiment (Gil et al., in press), we also assessed participants' prior knowledge concerning the topic of reading and used that as a covariate to isolate variance resulting from task and mode of presentation, as well as from their potential interaction. This is because a relationship between prior knowledge and multiple-text comprehension and integration has been observed in several studies (e.g., Bråten, Strømsø, & Britt, in press; Le Bigot & Rouet, 2007), with prior knowledge

presumably allowing readers to engage in bridging inferential processing to build links and coherence across texts.

4. 1. 2. METHOD

Participants

Eighty-seven first-year psychology undergraduates at the University of Valencia with an overall mean age of 19.7 years (*SD* = 4.3) participated in the experiment for extra course credit. The sample included 62 females and 25 males. All participants were native Spanish speakers. Participants were assigned randomly to conditions.

Materials

All materials used in the experiment were initially developed in Norwegian by the two Norwegian authors in collaboration with Marit Samuelstuen. In developing Spanish versions of the materials, care was taken to retain original meanings while making some necessary cultural adaptations. See Gil et al. (in press) for a detailed description of the Spanish adaptation of the materials.

Prior knowledge measure. To assess students' prior knowledge about climate change we used a multiple-choice test consisting of 21 items with five response options for each item. The content of the items referred to concepts and information central to the issue of climate change that were discussed in the five texts (sample item: *The Kyoto Protocol deals with a) trade agreements between rich and poor countries, b) reduction in the discharge of climate gases, c) the pollution of the Pacific Ocean, d) protection of the ozone layer, e) limitations on international whaling).* Taken together, the 21 items of the measure assessed both factual knowledge and conceptual understanding with respect to climate change. It should be noted that diverse aspects of the issue were covered by the prior knowledge measure, with items referring to both

scientific (e.g., the greenhouse effect) and political (e.g., the Kyoto Protocol) aspects of the topic. A preliminary version of the prior knowledge measure was reviewed by a climate researcher at the University of Oslo, with this resulting in only small modifications of the response alternatives of a couple of items.

Participants' prior knowledge score was the number of correct responses out of the 21 items. The test-retest reliability of the scores on the prior knowledge measure was computed in an independent sample of first-year psychology undergraduates (n = 77), with two weeks between the test and the retest. This yielded a reliability estimate (Pearson's r) of .99.

***Texts*.** Students read five separate texts about the topic of climate change. Each text first presented information about the document's source (i.e., author, publisher, and publication date). In the Spanish versions of the texts, authors and publishing channels were changed to create comparable national sources. The texts were presented to the participants in random order and they could read them in any order they preferred. Apart from a more neutral textbook excerpt explaining the natural greenhouse effect and the manmade greenhouse effect in relatively, neutral, academic terms, one popular science text was discussing manmade causes of global warming, one popular science text was arguing that global warming could be caused by astronomical conditions, one newspaper text was describing how global warming might result in access to new natural resources and an opening of a new sea passage between the Atlantic Ocean and the Pacific Ocean, and one public information text was discussing how manmade discharges leading to global warming could be reduced through international cooperation within the framework of the United Nations. Table 4.1 provides an overview of the five texts that were used in this study.

Table 4. 1

Overview of the Five Texts

.	Type of text	Publisher	Author	Content	*n* words
1.	Textbook in nature studies for upper secondary education	Publishing house	Teachers in upper secondary	Explanation of the natural greenhouse effect and the manmade greenhouse effect in relatively neutral, academic terms.	464
2.	Popular science text	Center for International Climate and Environmental Research	Not given	Focus on manmade discharges of climate gases into the atmosphere and their contribution to observed climate changes.	345
3.	Popular science article	University of Barcelona	Professor of theoretical astrophysics	Argues that climate changes to a large extent are steered by astronomical conditions and therefore due to natural causes.	332
4.	Newspaper article	Spanish conservative daily	Journalist	Description of the positive consequences of a warmer climate in northerly regions in terms of an ice free sea route through the Northwest Passage and the access to natural resources now concealed under the Arctic ice.	299
5.	Public information text	Spanish Pollution Control Authority	Not given	Discussion of international cooperation within the framework of the UN as a way to reduce the discharges of climate gases.	379

The texts about climate change were selected because (a) the participants were likely to have some, but not extensive, prior knowledge of the topic; (b) the texts represented different kinds of authentic source materials that educated adult readers typically encounter; and (c) the discussion of this highly topical scientific phenomenon from multiple perspectives, because of its strong individual and social implications, was likely to elicit interest and reflection on part of the readers.

Writing tasks. After reading, participants first wrote either summaries or argument essays depending on the experimental condition (see below). The same coding system was used for scoring the summaries and the argument essays. Following Magliano, Trabasso, and Graesser's (1999) procedure, we first segmented every summary and argument essay into idea units. An idea unit contained a main verb that expressed an event, activity, or state. If an utterance had two verbs and one agent, it was treated as having two separate idea units. Infinitives and complements were included with the main verb (Magliano et al., 1999).

Following segmentation, all segments were coded to indicate the degree of transformation and integration in students' compositions, respectively.

With respect to transformation, each idea unit was coded as representing one of four types of transformation of original text content. Inspired by the coding system developed by Wiley and Voss (1996), idea units were coded as paraphrases if students used their own words without changing the meanings expressed in the source material (e.g., *It now appears that for the first time mankind is facing a global climate change caused by its own activities* [from original text 1]/*Nowadays, all of us are also responsible for the global climate change* [from student summary]). Idea units were coded as elaborations if they contained some information from the source material in combination with some information from prior knowledge (e.g., *These manmade discharges of CO_2 are first and foremost due to the consumption of fossil fuels (coal, oil and gas) and the deforestation of tropical regions* [from original text 2]/*Our discharges of CO_2 to the atmosphere are due to the combustion of fossil fuels (oil, coal, and natural gas), which are primarily done by industry and transport and the destruction of tropical forests (Amazonas and other regions)* [from student argument essay]). Idea units were also coded as elaborations if they combined two or more pieces of information, either within or across texts, which were not connected in the source material (e.g., *Some of these gases in the atmosphere are called climate gases* [from

original text 1] and *Without the sun we would not have the greenhouse effect, which is a prerequisite for us having liveable conditions on our planet* [from original text 3]/*The atmosphere is composed of some gases called climate gases that, together with the sun, are necessary for us having an inhabitable earth* [across-text combination from student argument essay]). Idea units were coded as *additions* if they contained only related information from prior knowledge or personal opinions about climate change (e.g., *Some days ago, we listened to the leader of the opposition questioning the responsibility of human beings for the climatic change* [related information from prior knowledge from student argument essay]). Moreover, we supplemented the coding system created on the basis of Wiley and Voss' (1996) work with the category of *misconceptions.* Idea units were coded as misconceptions if they contained false statements in relation to the content of the source material (e.g., *In recent times, climate researchers have found that the earth's average temperature rose by approx. 0.5 °C between 1850 and 2004* [from original text 1]/*The temperature of the Earth has increased approximately 5 ºC in the last 100 years* [from student summary]).

We counted the number of different paraphrases, elaborations, and additions, as well as the number of different misconceptions, in each student's summary or argument essay. A global score indicating the degree of transformation was computed by adding the number of paraphrases, elaborations, and additions and subtracting the number of misconceptions from this sum score. In doing this, we decided to award two points for each elaboration and one point for each paraphrase or addition because the elaborations can be considered to reflect a greater degree of transformation in the sense of Wiley and Voss (1996) than both paraphrases and additions.

With respect to integration, we focused on the number of sources used by students and their merging of information from those sources. With respect to number of sources, many students seem to rely too heavily on one or two documents or perspectives in their essay writing (Britt et al., 2004). According to Britt et al. (2004), the

use of material from a variety of different sources in an essay may indicate "content integration from multiple sources" (p. 363). In this study, we therefore identified where every idea unit in a student's summary or argument essay came from and then simply counted the number of different texts that the student drew upon in their writing. Thus, while a score of five suggests a complete coverage of the texts in our set, a score of zero suggests a lack of content coverage. With respect to the merging of information, we followed the procedure of Britt and Sommer (2004) and counted the number of switches between sources in student summaries or argument essays. That is, if an essay contained 20 idea units altogether, and the first five idea units came from text 1, the next five idea units came from text 3, the next eight units came from text 5, and the last two units came from text 3, this would count as three switches and indicate relatively poor integration.

First, one of the Spanish authors coded each summary and argument essay with respect to transformation and integration, using the coding system for each aspect detailed above. Second, a doctoral student of psychology independently rated a random subset of summaries and argument essays (33 %) using the same coding systems, with this resulting in an overall interrater agreement of 87%.

Text comprehension measures. Readers' superficial understanding of single texts was measured with a sentence verification task (SVT) based on Royer, Carlo, Dufresne, and Mestre's (1996) procedure. The sentence verification task included three types of test sentences related to the causes of climate change that were generated from sentences in the text/s: (a) originals, which were copies of sentences that appeared in the text/s; (b) paraphrases, which were constructed by changing as many words as possible in original sentences without altering the meaning of the sentences; (c) and meaning changes, which were constructed by changing one or two words in original sentences so that the meaning of the sentences were altered. The participants were asked to mark a sentence *yes* if it had the same meaning as a text sentence

(originals or paraphrases) and *no* if it had a different meaning (meaning changes). A participant's score was the number of correct responses on the 14 items. The reliability for the scores on the sentence verification task (Cronbach's α) was .61 in the present study.

To assess participants' ability to make intertextual inferences we used an intertextual inference verification task (InterVT) based on the procedure used by Bråten and Strømsø (in press). This involves taking pieces of information presented in different texts and drawing inferences that connect them. The participants were instructed in writing that each of the test sentences consisted of a statement that could "reasonably be inferred by combining information from a least two of the texts" they had just read, or of a statement that "could not reasonably be inferred by combining information from at least two of the five texts." In constructing the measure, we took care to insure that an item could not be answered correctly by judging the validity of only one piece of information at a time, that is, without considering the whole, integrated meaning of the statement. For example, the item, *Mankind's discharges of carbon dioxide amount to only a small part of the quantity of climate gases released into the atmosphere, and these discharges are therefore not included in the international cooperation within the framework of the UN's convention*, combined information from the text focusing on the causes of the manmade greenhouse effect with information from the text discussing international cooperation within the framework of the UN to form an *invalid* inference. Even though the two parts of the statement "go together" and the statement as a whole seems to make perfectly sense, the inference it contains can not be reasonably drawn by combining information from the two texts, and the statement is therefore categorized as an invalid inference. The InterVT consisted of 12 items, 7 of which could be inferred by combining information from at least two of the texts (i.e., valid inferences), and 5 of which could not be inferred by combining information from at least two of the texts (i.e., invalid inferences). The participants were

instructed to mark the valid inferences *yes* and the invalid inferences *no*. Participants' score on the InterVT was the number of correct responses out of the 12 items. The reliability (Cronbach's α) for the scores on this task was .62. Further information about the InterVT-procedure is given in prior work (Bråten et al., 2008; Bråten & Strømsø, in press).

Procedure

The experiment was conducted in two sessions. In the first session, the 87 participants were group administered the prior knowledge measure during a regular lecture, using approximately 20 minutes to complete this questionnaire. In the second session, participants performed the experimental tasks in groups of 10 or 20 depending on the condition, first reading five separate texts about climate change and then writing either a summary or an argument essay. Participants were randomly assigned to task condition. Before starting on the texts, those in the summary condition (n = 41) read the following instruction: *Imagine that you have to write a brief report to other students that summarizes the causes of climate change*. The participants in the argument condition (n = 46) were given the following written instruction: *Imagine that you have to write a brief report to other students where you express and justify your personal opinion about what are the causes of climate change.* In addition, participants in both conditions were instructed: *Base your report on information included in the following five texts. You will find information which is relevant for writing your report and information which is not relevant for writing it. Use the most relevant information, and try to express yourself clearly and to elaborate the information—preferably in your own words*. All the participants were also informed that they could read and reread the documents in the order they preferred. Finally, students were informed that they would be allowed 35 minutes to work on the texts and 15 minutes to write either the summary or the argument essay, and that they would not be able to look back to the texts while performing the writing tasks.

Half of the participants in each task condition were randomly assigned to read the five texts and perform the writing task on a laptop using the software *Read&Answer* (i.e., computer-based environment). These participants worked in groups of 10 in a university lab, and they were first trained for 10-15 minutes to use the software with tasks similar to the experimental ones, using different and shorter documents. When starting on the experimental tasks, participants first saw a screen with the instruction for the condition to which they were assigned. In the Read&Answer application, each text was presented on two sequential pages. A simple interface allowed readers to navigate among texts and pages within a text. The reader saw one page of text on the screen at a time, with all text on the page masked except the segment currently selected by the reader. The reader could unmask and thereby read a segment of approximately 70 words by clicking, and when clicking on another segment, the previously selected segment was remasked so that only one segment was visible at a time (Figure 4.1a).

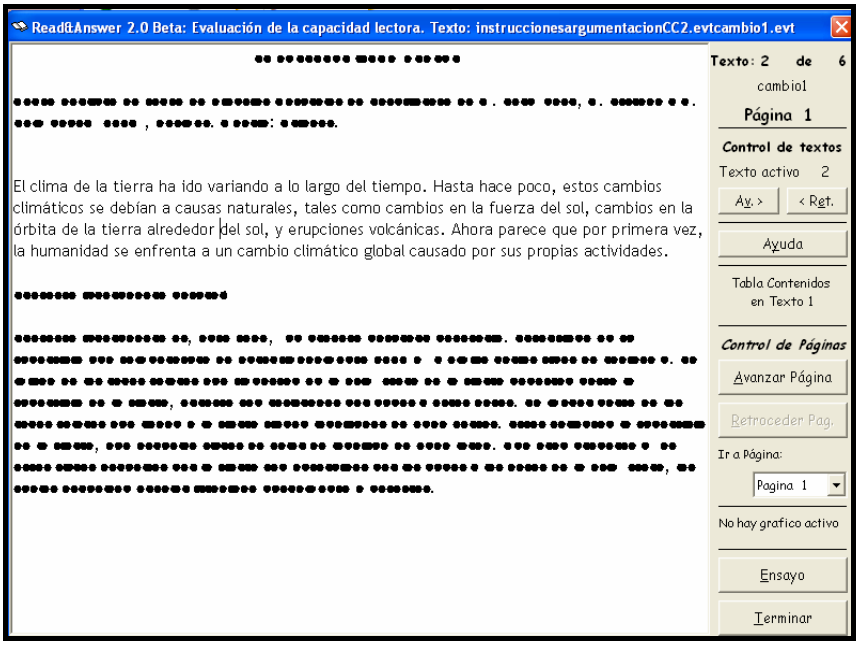

Figure 4.1a. Reading screen of the Read&Answer application

The application permitted students to jump between pages in any order and unmask a segment in any location on a page. After reading, students performed the summary or the argument essay task on a blank screen (Figure 1b) without looking back to the texts.

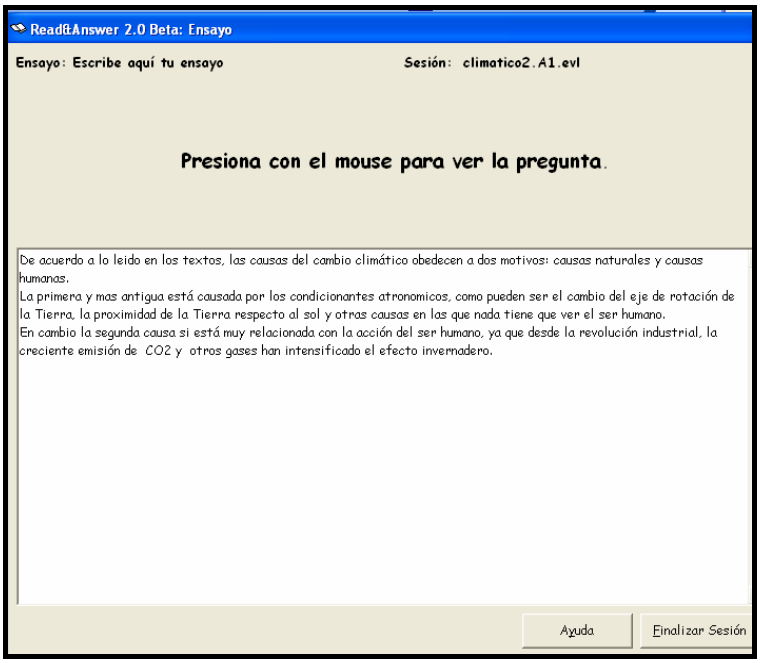

Figure 4.1b. Writing task screen of the Read&Answer application

The other half of the participants in each task condition were randomly assigned to a paper-and-pencil environment where they worked in groups of 20 in a classroom. These participants received the same task instructions and read the same texts on paper, with each text printed on one separate sheet of paper. The texts were presented in random order in a folder and the participants could read them in any order they preferred. After reading, they performed the writing task on a blank sheet of paper.

After reading and writing, all participants in the experiment were administered the SVT and the InterVT on paper. They were allowed as much time as they needed to

complete these two measures of text comprehension. Everyone completed the entire experimental session within 100 minutes.

4. 1. 3. RESULTS

Table 4. 2 shows the descriptive statistics (means, standard deviations, and coefficients of skewness) for all the measured variables for the entire sample. These data indicated that all score distributions were approximately normal and, thus, appropriate for use in parametric statistical analyses.

Table 4. 2

Means, Standard Deviations, and Coefficients of Skewness for All Measured Variables for the Entire Sample

Variable	*M*	*SD*	Skewness
Prior Knowledge	6.03	2.49	.35
SVT	9.34	2.07	.03
InterVT	6.30	2.04	-.15
Trans	17.30	7.06	.55
Texts	3.49	1.10	-.21
Switches	3.70	1.89	.26

Note. SVT = Sentence verification task, InterVT = Intertextual inference verification task, Trans = overall content transformation, Texts = number of texts used, Switches = number of switches between sources.

Text Comprehension Measures

To test our hypotheses, we first performed two separate 2 x 2 between-subjects analyses of covariance (ANCOVAs) on the two text comprehension measures. Independent variables in each analysis were task condition (summary and argument essay) and mode of presentation (computer-based and paper-and-pencil). Covariate in the analyses was prior knowledge. In the first analysis, the sentence verification task

(SVT) was the dependent variable; in the second analysis, the intertextual inference verification task (InterVT) was the dependent variable.

Table 4. 3

Adjusted Marginal Means and Standard Errors for the Text Comprehension Measures by Task Condition and Mode of Presentation

	Task condition							
	Summary				Argument essay			
	SVT		InterVT		SVT		InterVT	
Mode of	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Paper-and-pencil	9.65	.45	6.73	.39	8.70	.42	5.51	.39
Computer-based	10.01	.44	7.19	.42	9.00	.43	5.97	.41

Note. SVT = Sentence verification task, InterVT = Intertextual inference verification task.

Table 4.3 shows the adjusted marginal means and standard errors for each of the four groups on the two text comprehension measures. The ANCOVA on the SVT indicated a statistically significant main effect of task condition, with $F(1, 82) = 5.10$, $p = .027$, partial $\eta^2 = .06$. After adjustment by prior knowledge, students in the summary condition ($M = 9.83$) outperformed students in the argument condition ($M = 8.85$). No statistically significant main effect of mode of presentation was found; nor was there a statistically significant interaction between task condition and mode of presentation after adjustment by prior knowledge.

Also, scores on the InterVT varied statistically significantly with task condition after adjustment by prior knowledge, with $F(1, 82) = 9.31$, $p = .003$, partial $\eta^2 = .20$. Again, the adjusted marginal means showed that the students in the summary condition ($M = 6.96$) performed better than did the students in the argument condition ($M = 5.74$). There was also no statistically significant main effect of mode of

presentation or a statistically significant interaction between task condition and mode of presentation after adjustment by prior knowledge in this analysis.

Only in the ANCOVA on the InterVT did the covariate of prior knowledge uniquely adjust text comprehension after adjustment for main effects and interaction, with $F(1, 82) = 6.66$, $p = .01$, partial $\eta^2 = .07$. This indicated that high-knowledge participants were likely to gain better intertextual understanding from reading the five texts than were low-knowledge participants.

Table 4.4

Adjusted Marginal Means and Standard Errors for the Writing Task Measures by Task Condition and Mode of Presentation

Task condition												
	Summary						Argument essay					
	Trans		Texts		Switches		Trans		Texts		Switches	
Mode of presentation	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Paper-and-pencil	17.19	1.33	3.77	.22	4.47	.35	14.28	1.35	3.38	.23	3.16	.36
Computer-based	20.50	1.45	3.75	.24	4.48	.38	17.67	1.45	3.09	.24	2.88	.38

Note. Trans = overall content transformation, Texts = number of texts used, Switches = number of switches between sources.

Next, we performed three separate 2 x 2 ANCOVAs on the writing task measures, using the same independent variables and the same covariate as in the ANCOVAs on the two text comprehension measures. Dependent measures in these ANCOVAs were overall content transformation, number of texts used, and number of switches between sources in student compositions, respectively. Table 4. 4 shows the

adjusted marginal means and the standard errors for the four groups on the three writing task measures. The ANCOVA on the measure of overall content transformation indicated a statistically significant main effect of task condition, with $F(1, 82) = 5.56$, $p = .021$, partial $\eta^2 = .06$. After adjustment by prior knowledge, students in the summary condition ($M = 18.72$) displayed a greater degree of transformation in their writings than did students in the argument essay condition ($M = 15.84$). Overall content transformation also varied statistically significantly with mode of presentation, $F(1, 82) = 4.28$, $p = .041$, partial $\eta^2 = .05$, with the adjusted marginal means showing that the participants who performed the task in the computer-based environment ($M = 19.08$) displayed a greater degree of transformation than did the participants in the paper-and-pencil environment ($M = 15.74$). Follow-up ANCOVAs with each of the four transformation categories (i.e., paraphrases, elaborations, additions, and misconceptions) as dependent variables were performed to further examine this unexpected difference. Only the ANCOVA on the number of additions yielded a statistically significant main effect of mode of presentation, $F(1, 82) = 15.56$, $p = .000$, partial $\eta^2 = .15$. Thus, the observed difference in overall content transformation was located in the number of additions. The adjusted marginal means showed that students in the computer-based environment ($M = 5.05$) included a higher number of additions in their writings than did the students in the paper-and-pencil environment ($M = 2.50$). No statistically significant interaction between task condition and mode of presentation was found in the analysis concerning content transformation after adjustment by prior knowledge.

With respect to the measures of integration, the ANCOVA on the number of texts showed a statistically significant main effect of task condition, with $F(1, 82) = 5.20$, $p = .025$, partial $\eta^2 = .06$. As can be see in Table 4. 4, students in the summary condition ($M = 3.76$) used a greater number of different texts in their writings than did those in the argument condition ($M = 3.23$). We also found a statistically significant

main effect of task condition in the ANCOVA performed with the number of switches between sources as the dependent variable, $F(1, 82) = 16.01$, $p = .000$, partial $\eta^2 = .16$. Students in the summary condition ($M = 4.48$) made a greater number of switches in their compositions than those in the argument condition ($M = 3.02$). There were no statistically significant main effects of mode of presentation or interactions between task condition and this variable in any of the analyses concerning integration. The covariate of prior knowledge did not uniquely adjust scores in any of the ANCOVAs with writing task measures as dependent variables.

4. 1. 4. DISCUSSION

In this experiment, we compared the effects of summary and argument essay tasks on students' comprehension and integration of multiple texts as a follow-up to a previous study where we, somewhat surprisingly, found that students in the summary condition outperformed students in the argument condition with respect to both text comprehension measured by means of verification tasks and writing performance measured by means of content transformation and integration in student compositions. By having the students work with fewer documents, we thought that the extra time available for the effortful and complex processing required by the argument task might make this task more facilitative than the summary task in this experiment, as has been observed in other research (Le Bigot & Rouet, 2007; Wiley & Voss, 1999). Moreover, we thought it might be easier for students in a paper-and-pencil environment to perform the cross-text processing required by the argument task than for students in a computer-based environment having to unmask small text segments for reading one at a time, with this, possibly, making the effect of task on the comprehension and integration of multiple texts dependent on the mode of presentation. However, consistent with our previous experiment (Gil et al., in press), students in the summary condition again outperformed students in the argument condition with respect to both the text comprehension measures and the writing task measures. More specifically,

participants who read the texts in order to write a summary obtained higher scores on the measures developed to assess superficial understanding of each single text and the ability to draw inferences across texts, respectively. Likewise, in their compositions, participants in the summary condition produced more transformations, covered the text materials more completely, and merged information from the different sources to a larger extent than did students in the argument essay condition.

Thus, this experiment makes it less likely that the lack of benefit of the argument task that we observed in our previous experiment was due to the limited time available to study the documents. At the same time, the possible explanation that our previous findings were dependent on the mode of presentation could be ruled out by our present experiment. In this way, this experiment could be said to bolster the assumption that argument tasks are not optimal for everyone, bringing the issue of which reader characteristics are required to take advantage of this task condition to the forefront. As argued by Gil et al. (in press), one likely candidate to moderate the effect of task condition on the comprehension and integration of multiple texts is the prior knowledge of the reader. To examine this possibility, we conducted a second experiment to test whether the facilitative effect of the argument task would be limited to students with high prior knowledge about the topic of the texts.

It should also be noted that the students in the computer-based environment made more transformations in the form of additions when performing the writing task than did the students in the paper-and-pencil environment. A plausible explanation for this is that many students felt that they ought to fill either the sheet of paper or the blank screen to complete the writing task satisfactory, and that they tended to do this by adding related information from prior knowledge or personal opinions about climate change. Given that the number of words required to fill the blank screen was much greater than that required to fill the sheet of paper, this may have resulted in more additions being included in the computer-based environment. This explanation is also

supported by the fact that most of the idea units coded as additions were located at the end of the students' writings.

4.2. EXPERIMENT 2

Both the schema-theoretic view of Anderson (1994) and the construction-integration model of Kintsch (1988) provide insights into how prior knowledge affects comprehension. Schemas represent top-down knowledge tools used to draw inferences and construct coherent mental representations during reading (Anderson, 1994). In the construction-integration model, readers can move beyond the bottom-up constructed, text-internal meaning of the text and construct a situation model that integrates the text meaning with prior knowledge relevant to the text (Kintsch, 1988). Indeed, Kintsch (1998) argued that learning from text requires that text information is integrated with the reader's prior knowledge and becomes a part of it, so that it can support understanding and problem solving in new contexts. With respect to multiple-text comprehension, in particular, several studies indicate that readers' prior knowledge about the topic plays an important role (e.g., Bråten et al., in press; Moos & Azevedo, 2008; Pieschl, Stahl, & Bromme, 2008; Strømsø, Bråten, & Britt, 2008; Wineburg, 1991). It is possible, however, that different multiple-documents tasks demand different levels of prior knowledge, with tasks asking readers to construct arguments from texts expressing diverse and even contradictory views on a topic being especially challenging to low knowledgeable readers. This possibility is also consistent with cognitive flexibility theory (Spiro et al., 1991, 1994), suggesting that exploring contrasting perspectives located in multiple sources is more beneficial at relatively advanced than at introductory level of domain knowledge.

One mechanism that could explain why argument tasks may demand more of readers in terms of prior knowledge is the complex, cross-text processing involved in the performance of such tasks. In an investigation of readers learning about the

circulatory system by studying articles containing hyperlinks in an online encyclopaedia, Moos and Azevedo (2008) demonstrated, accordingly, that high prior knowledge may be needed to draw inferences and use metacognitive processes (i.e., monitoring and planning) productively during multiple-documents reading. In that study, low-knowledge students tended to rely on a few, specific strategies such as note taking and summarizing during reading, with such strategies presumably more suitable for performing summary tasks such as the one given in our experiments than more challenging argument tasks. Also, McNamara, Kintsch, Songer, and Kintsch (1996) suggested the low-knowledge readers may be less able to cope with demanding task conditions where they have to link concepts and ideas and build a coherent representation on their own by engaging in "gap-filling" inferential processing. Consistent with this, McNamara (2001, 2004) found that reading strategy instruction only facilitated low-knowledge participants' performance on text-based comprehension questions and not on bridging-inference questions, indicating that without sufficient knowledge, readers have difficulties linking distant pieces of information and drawing knowledge-based inferences.

To the best of our knowledge, however, no previous multiple-text study except Le Bigot and Rouet (2007) has directly investigated the possibility that the advantage of argument tasks may be limited to high knowledgeable readers. In that study, it was found that high-knowledge readers obtained statistically significantly higher scores on comprehension questions concerning explicit main ideas but no differences were found between the knowledge groups on inferential comprehension questions or on writing measures. Moreover, no statistically significant interactions between task condition (argument and summary) and prior knowledge (high and low) were observed. That high-knowledge readers in that study did not obtain higher scores on situation model (inferential) comprehension questions or produced more integrated or transformed essays than did low-knowledge readers may, however, suggest that the difference with

respect to prior knowledge about the topic of reading (social influence) was quite small between the knowledge groups. In further examining the possibility that high-knowledge readers may be more able to profit from the complex task of constructing arguments from texts than are low-knowledge-readers, we took great care to ensure that the participants in our second experiment differed substantially with respect to their prior knowledge about the topic of climate change.

4. 2. 1. OBJECTIVE AND HYPOTHESES

The purpose of the second experiment was to test whether the effect of task on multiple-text comprehension and integration was moderated by participants' prior knowledge about the topic of reading. Specifically, given the generally low level of prior knowledge about climate change among the participants in our prior research, we wanted to clarify whether the potentially facilitative effects of the argument task that we used were restricted to more knowledgeable readers. In the current experiment, we therefore tried to avoid a general mismatch between the level of prior knowledge of participants and the challenging task of having to construct arguments from complex scientific texts by providing some students with relevant knowledge about climate change before reading the texts. We hypothesized that only the students acquiring relevant prior knowledge about the topic would be able to take advantage of the argument task and, thus, outperform those in a control group in this task condition. Based on our previous findings, we also expected that students not given specific instruction about the topic would be better off in the summary than in the argument condition, with this resulting in an interaction effect of task with prior knowledge on multiple-text comprehension and integration.

4. 2 .2 . METHOD

Participants

Forty-seven second-year psychology undergraduates of the University of Valencia with an overall mean age of 22.4 years (*SD* = 4.9) participated in the experiment for extra course credit. The sample included 40 females and 7 males. All participants were native Spanish speakers. Participants were assigned randomly to conditions.

Materials

The measure of prior knowledge, the two measures of text comprehension, and the three measures of writing performance used in this experiment were exactly the same as those used in the first experiment, and the participants also read the same five texts about climate change.

Procedure

The experiment was conducted in two sessions with an interval of two days. In the first session, the 47 participants were randomly assigned to two groups, with participants in one of the groups (*n* = 22) taught relevant prior knowledge about climate change during a 40-min lecture, and participants in the other group (*n* = 25) being presented with irrelevant but thematically related information in the same period of time. Participants in both groups were told at the beginning of the lecture that the content would be related to the tasks that they were to perform two days later, and that they therefore should pay close attention during instruction. The lecture related to climate change was given by the first author to all participants in the group at once, explaining the natural greenhouse effect and the natural CO_2 cycle, as well as how both astronomical conditions and manmade discharges of climate gases into the atmosphere may be related to changes in the Earth`s temperature. The information

was presented through a number of PowerPoint slides, and at the end, participants were asked seven questions about the main ideas of the presentation that were answered orally by group members. The lecture providing irrelevant information was given by the third author to all the participant in the other group at a time, using about the same number of PowerPoint slides to explain the classification of the world`s climate into different regions (i.e., climate zones) and the parameters used to define those regions, for example, temperature and rainfall. This information was thematically related to climate change but actually irrelevant for performing the experimental tasks. The participants in this group were also asked seven questions at the end of the lecture, with these questions answered orally by group members.

Before the second session, half of the students given the lecture related to climate change and half of the students provided with irrelevant information were randomly assigned to either the summary (n = 23) or the argument (n = 24) condition. In the second session, participants worked in groups of 10 in a university lab, where they were first group administered the prior knowledge measure on paper, using approximately 20 minutes to complete it. Students were then individually performing the experimental tasks in either the summary or the argument condition. Because no difference was found between the paper-and pencil and the computer-based presentations in the first experiment, all participants used the *Read&Answer* application for this experiment. This application, as well as the exact procedure used in the two task conditions, is described in connection with the first experiment. Again, participants were allowed 35 minutes to read the texts and 15 minutes to write either the summary or the argument essay**,** and the two text comprehension measures were administered after the participants had completed the writing tasks. Everyone completed the prior knowledge measure and the experimental tasks within 120 minutes.

4. 2. 3. RESULTS

Table 4. 5 shows the descriptive statistics (means, standard deviations, and coefficients of skewness) for all the measured variables for the entire sample.

Table 4.5

Means, Standard Deviations, and Coefficients of Skewness for All Measured Variables for the Entire Sample

Variable	*M*	*SD*	Skewness
Prior Knowledge	10.09	4.02	-.03
SVT	9.30	2.20	-.80
InterVT	7.00	2.42	.02
Trans	14.93	6.12	-.01
Texts	3.57	1.11	-.48
Switches	3.78	1.74	.56

Note. SVT = Sentence verification task, InterVT = Intertextual inference verification task, Trans = overall content transformation, Texts = number of texts used, Switches = number of switches between sources.

To test our hypotheses, we performed two separate 2 x 2 between-subjects analyses of variance (ANOVAs) on the two text comprehension measures, that is, the sentence verification task (SVT) and the intertextual inference verification task (InterVT). In each analysis, independent variables were task condition (summary and argument essay) and prior knowledge (high and low). Prior knowledge groups were formed according to a median split on participants' prior knowledge scores. Thus, like McNamara and Kintsch (1996), we did not form high and low knowledge groups solely on the basis of whether participants were taught relevant information or not before text reading. The reason why median splits were used to form high and low knowledge groups instead, was that some of the students given relevant information did not seem

to profit much from the instruction, whereas some students given irrelevant information displayed high prior knowledge on the multiple-choice prior knowledge measure even without any relevant instruction. In this way, we took real differences in prior knowledge more into consideration than the experimental manipulation.

The group with high prior knowledge was composed of 22 students, 18 of whom had been lectured about climate change, and the group with low prior knowledge was composed of 25 students, 18 of whom had been presented with irrelevant information. The median for the scores on the prior knowledge measure was 10.09, and the participants classified as having high knowledge (M = 13.59, SD = 2.17) scored statistically significantly higher than participants classified as having low knowledge (M = 7.00, SD = 2.38), with $t(45) = 9.86$, $p = .000$, Cohen`s $d = 2.90$.

Table 4. 6

Means and Standard Deviations for the Text Comprehension Measures by Task Condition and Prior Knowledge

	Task condition							
	Summary				Argument essay			
	SVT		InterVT		SVT		InterVT	
Prior Knowledge	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
High	8.09	2.26	6.45	2.07	10.82	1.18	8.82	1.78
Low	9.23	2.09	6.85	2.41	9.08	2.39	6.00	2.59

Note. SVT = Sentence verification task, InterVT = Intertextual inference verification task.

Table 4. 6 shows the means and standard deviations for each of the four groups on the two text comprehension measures. No statistically significant main effects of task or prior knowledge were found when the SVT was used as the dependent variable. However, as hypothesized, the ANOVA on the SVT indicated a statistically

significant interaction between task and prior knowledge, with $F(1, 43) = 5.78$, $p = .021$, partial $\eta^2 = .12$. The nature of this interaction is displayed in Figure 4. 2. Post-hoc comparisons using Fisher's least significant difference (LSD) procedure showed that participants with high prior knowledge gained better superficial understanding in the argument condition than in the summary condition ($p = .003$), outperforming participants with low prior knowledge in the argument condition ($p = .048$), but not in the summary condition ($p = .181$). Participants with low prior knowledge achieved almost identical levels of superficial understanding in both conditions.

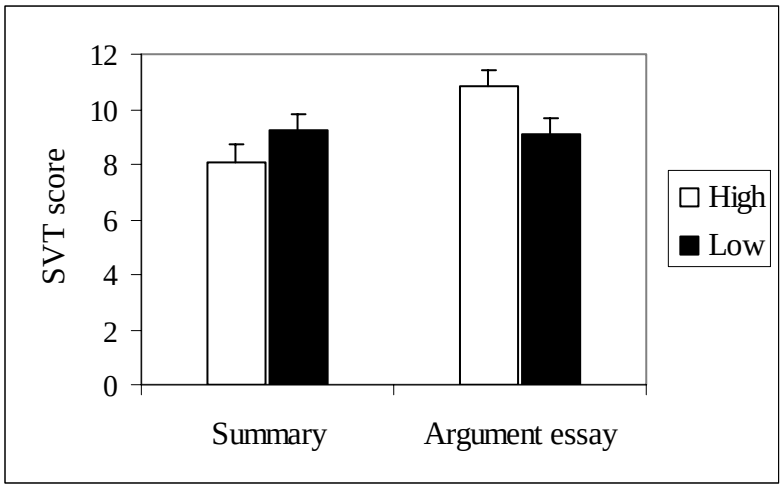

Figure 4.2. Interaction effect of task condition with prior knowledge on the sentence verification task (SVT). Error bars represent standard errors.

The main effects of task or prior knowledge were also not statistically significant in the ANOVA using the InterVT as the dependent variable. Again, we found a statistically significant interaction between task and prior knowledge, $F(1, 43) = 5.94$, $p = .019$, partial $\eta^2 = .12$. This interaction is illustrated in Figure 4. 3. Using Fisher's LSD procedure, we determined that participants with high prior knowledge scored higher in the argument condition than in the summary condition ($p = .018$), also outperforming participants with low prior knowledge in the argument condition ($p = .005$). However, no

statistically significant difference between the knowledge groups appeared in the summary condition (p = .673.). Participants with low prior knowledge did not perform statistically significantly better in the summary condition than in the argument condition (p = 353).

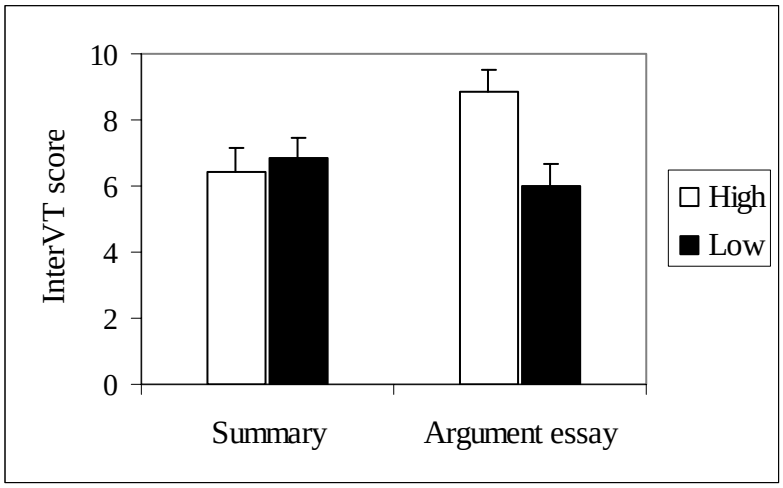

Figure 4. 3. Interaction effect of task condition with prior knowledge on the intertextual inference verification task (InterVT). Error bars represent standard errors.

Writing Task Measures

Finally, we performed three separate 2 x 2 ANOVAs on the writing task measures using task condition and prior knowledge as independent variables. Table 4.7 shows the means and standard deviations for the four groups on the three dependent measures. Please note that because all writing data were lost for one participant in the argument condition, the number of available participants for statistical analyses involving the writing task measures was 46.

Table 4.7

Means and Standard Deviations for the Writing Task Measures by Task Condition and Prior Knowledge

	Task condition											
	Summary						Argument essay					
	Trans		Texts		switches		Trans		Texts		Switches	
Prior knowledge	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
High	17.45	3.30	3.64	1.12	4.09	1.45	19.82	5.67	3.82	.98	4.82	2.14
Low	13.75	4.67	3.58	1.08	3.75	1.14	9.33	5.12	3.25	1.29	2.58	1.51

With respect to overall content transformation, there was a statistically significant main effect of prior knowledge, $F(1, 42) = 25.30$, $p = .000$, partial $\eta^2 = .12$, with participants having high prior knowledge displaying a greater degree of transformation in their compositions ($M = 18.64$, $SD = 4.69$) than did participants having low prior knowledge ($M = 11.54$, $SD = 5.30$). Additionally, we found a statistically significant interaction between task and prior knowledge, $F(1, 42) = 5.76$, $p = .021$, partial $\eta^2 = .38$, with this interaction illustrated in Figure 4.4. Post-hoc comparisons with Fisher's LSD showed that participants with high prior knowledge in the argument condition wrote essays with more transformed content than did participants with low prior knowledge in the same task condition ($p = .000$).

However, high knowledge participants did not produce statistically significantly more transformations in the argument task than in the summary task ($p = .253$). In the summary condition, the difference between high and low knowledge participants did not reach statistical significance ($p = .07$) but, as predicted, participants with low prior

knowledge wrote more transformed compositions in the summary condition than in the argument condition (p = .03).

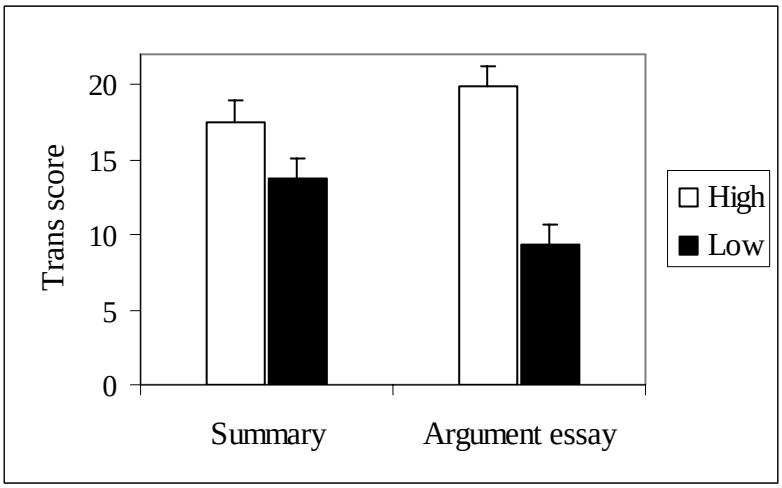

Figure 4.4. Interaction effect of task condition with prior knowledge on overall content transformation (Trans). Error bars represent standard errors.

The ANOVA on the number of texts used did not yield any statistically significant main effects or any interaction between task condition and prior knowledge. However, the ANOVA on the number of switches between sources indicated a statistically significant main effect of prior knowledge, $F(1, 42) = 7.56$, p = .008, partial η^2 = .15, with participants with high prior knowledge merging information to a greater extent (M = 4.45, SD = 1.89) than did participants with low prior knowledge (M = 3.17, SD = 1.43). Also, we found a statistically significant interaction effect of task with prior knowledge on this measure, $F(1, 42) = 4.09$, p = .05, partial η^2 = .09. This interaction in displayed in Figure 4. 5. The post-hoc comparisons with Fisher's LSD indicated a statistically significant difference in the favour of high knowledge participants in the argument condition (p = .002), but the high knowledge participants did not make statistically significantly more switches in the argument condition than they did in the summary condition (p =.288). In the summary condition, the number of switches produced by the participants with high and low prior knowledge was almost identical.

Finally, participants with low prior knowledge made a greater number of switches between sources in the summary condition than in the argument condition but this difference did not reach a conventional level of statistical significance (p =.078).

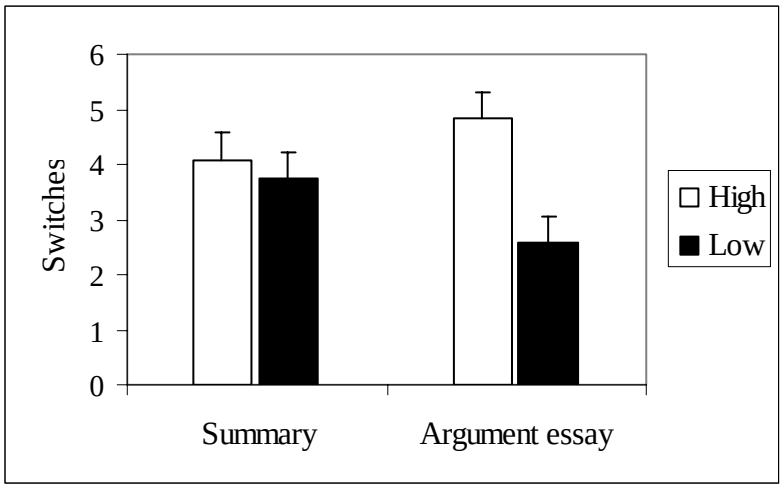

Figure 4. 5. Interaction effect of task condition with prior knowledge on number of switches between sources (Switches). Error bars represent standard errors

4. 2. 4. DISCUSSION

In this experiment, we took measures to insure that our participants differed substantially with respect to prior knowledge by providing some of them with relevant information about climate change before performing the experimental reading and writing tasks. In this way, we were able to investigate whether the effect of argument tasks on the comprehension and integration of multiple documents might be dependent on readers' level of prior knowledge. We hypothesized that only the students possessing high prior knowledge about the topic of reading would benefit from the argument task, whereas students with low prior knowledge, in accordance with our previous findings, would actually do better when given a summary task than when given an argument task.

The results of the present experiment showed a statistically significant interaction effect of task with prior knowledge on four of the five dependent variables. With respect to both text comprehension measures, students with high prior knowledge

outperformed students with low prior knowledge in the argument condition. Also, whereas high knowledge students performed better on these measures in the argument than in the summary condition, no differences were found for the low knowledge students across the two task conditions. These findings indicated that, as expected, only the more knowledgeable readers were able to take advantage of the argument task, but they were not consistent with our assumption that less knowledgeable readers would actually perform better in the summary than in the argument condition.

With respect to the writing task measures, high knowledge students, as expected, produced more transformed compositions and included a greater number of switches between sources than did low knowledge students in the argument condition. Also as expected, low knowledge students were found to produce less transformed and integrated compositions in the argument than in the summary condition. However, it was not consistent with our assumption that no differences were found for the high knowledge students across the task conditions on overall content transformation or number of switches. On the third writing task measure, concerning the number of texts used by the students in their compositions, no effects were found.

Taken together, this experiment revealed that high knowledge readers may benefit from instructions to construct arguments from multiple documents, as indicated by the results concerning the text comprehension measures, or at least not be cognitively overwhelmed by this demanding task condition, as suggested by the results involving the writing task measures. On the other hand, low knowledge readers may not be able to benefit from the argument task, as indicated by the findings for the text comprehension measures, and they may even may be disadvantaged by the argument task to the extent that they do worse on such a task than on a summary task, as indicated by the findings regarding the writing task measures. Thus, this experiment corroborates prior research demonstrating that readers' prior knowledge about the

topic may play an important role for multiple-text comprehension (e.g., Bråten et al., in press; Moos & Azevedo, 2008; Wineburg, 1991), also adding to this picture that higher levels of prior knowledge may be particularly needed to succeed on more challenging argument tasks.

It should be noted that results were not quite consistent across text comprehension and writing task measures in the present experiment. First, high knowledge students were found to perform better on the text comprehension measures in the argument than in the summary condition but no statistically significant differences were found on the writing task measures across tasks. Second, low knowledge students were found to produce better compositions in the summary than in the argument condition but no statistically differences were found on the text comprehension measures across tasks. In other words, the beneficial effect of the argument task for high knowledge students seemed to be most pronounced on the reading measures while the detrimental effect of the argument task for low knowledge students seemed to be most pronounced on the writing measures. Such inconsistency across assessment procedures has also been observed in other research examining the effects of task on multiple-documents comprehension (Le Bigot & Rouet, 2007), suggesting that different aspects of multiple-documents literacy may be captured by different procedures and that follow-up work in this area should take care to avoid a mono-operation bias (Cook & Campbell, 1979) implying that only one or a few aspects of this complex construct are assessed.

4. 3. GENERAL DISCUSSION

This article reports on two experiments that contributes to the growing field of multiple-documents literacy by suggesting that the kind of argument tasks much used in school, such as asking students to read multiple documents to form and express their own opinion about a particular topic, are not universally facilitative. While previous

research on the effects of tasks on multiple-documents comprehension and integration have produced inconsistent results, with some of them speaking for the advantage of instructing students to construct their own arguments while reading (Le Bigot & Rouet, 2007; Naumann et al., in press; Schwartz, 2003; Wiley & Voss, 1999), and others suggesting that argument tasks are not necessarily preferable to other tasks (Bråten & Strømsø, in press; Gil et al., in press; Kobayashi, in press), our findings may explain some of this inconsistency by providing new evidence that multiple-documents tasks may have to be adapted to individual characteristics of the reader. Specifically, it was revealed that among low-knowledge readers, much applauded and used argument tasks may not be productive and even have detrimental effects on some aspects of multiple-documents literacy, with instructions to summary information presented in a set of documents seemingly better adapted to the knowledge level of such readers. At the same time, our findings indicated that only readers possessing considerable prior knowledge about the topic discussed in a set of documents may profit from instructions to construct arguments based on document contents, with summary tasks seemingly hindering such readers to realize their potential for mastering some aspects of multiple-documents literacy.

In terms of theory, we believe that the current research is important because it extends our knowledge of what may be required to develop multiple-documents literacy. Thus, whereas quite a few studies have linked higher-order processes and skills to the comprehension and integration of multiple documents (for review, see Bråten & Strømsø, 2008), very few studies have examined possible interactions among different constructs (Bråten & Strømsø, in press; Gil et al., in press; Kobayashi, in press; Le Bigot & Rouet, 2007). Among those, the present study is probably the first to show that the effect of task on multiple-documents literacy may be moderated by readers' prior knowledge about the topic dealt with in the documents. This result is consistent with work within the single-text paradigm suggesting that the effect of

reading task on comprehension may depend on individual differences in prior knowledge (McNamara et al., 1996). Likewise, it accords with the cognitive flexibility theory of Spiro et al. (1991, 1994), positing that higher levels of prior knowledge may be needed to benefit from representing different intellectual points of view located in multiple information sources.

In terms of education, this work suggests that instructors should be aware that less knowledgeable readers may need some additional scaffolding support when asked to study multiple information sources in order to construct and present their own arguments on a particular topic. In addition to directly teaching students about the topic, such as we did in our experimental setup, instructors may encourage students to gain knowledge by reading and summarizing information on their own or together with peers before concentrating on forming personal opinions. Moreover, an aspect of this support may be to assign argument tasks that can be completed as part of group work where students with less prior knowledge participate in group discussions and shared writing with more knowledgeable peers (cf., Schwarz, 2003). Given the importance of mastering complex argument tasks, not only in academic contexts but also for participation in a democratic society, it seems crucial that students with less prior knowledge are given ample opportunity to build a knowledge base that can help them take advantage of the benefits that such tasks may offer.

Even though we believe that the present work contributes to the literature on multiple-documents literacy because it affords implications not only for theory but also for educational practice, it should be acknowledged that our experiments, of course, come with certain limitations. First, it should obviously be cautioned against imputing generalizability for our findings based on samples of Spanish psychology undergraduates reading multiple documents on the topic of climate change. As these participants' experience with handling multiple documents and performing summary and arguments tasks may differ from participants drawn from other student

populations, further research is needed that involves different student populations and that, preferably, is conducted in different cultural contexts. At the same time, further research is needed to examine whether our findings regarding an interaction effect of task condition with prior knowledge on the comprehension and integration of multiple documents could be replicated with scientific topics other than climate change, as well as with topics in other content areas.

Second, because participants' text processing was not focused in this research, we lack information about how participants differing with respect to prior knowledge processed the content of the documents in the different task conditions. For example, while the possibility exists that high knowledge readers were more likely than low knowledge readers to engage in complex, cross-text processing while performing the argument task, further research collecting on-line think-aloud, eye-movement, or log-file data are required to shed light on this issue, holding theoretical as well as educational implications.

Third, the use of multiple documents involves very complex processes and its components are thus far not well understood (Rouet, 2006). For sure, this represents a challenge for researchers wanting to measure important aspects of multiple-documents literacy. In the current research, we used a combination of comprehension questionnaires and writing tasks to measure participants' comprehension and integration of the documents. We acknowledge, however, that the types of questionnaires that we used and the coding system that we developed to assess writing performance captured only some aspects of multiple-documents literacy but probably disregarded other ones. In this area it seems important that further work to develop more reliable and valid assessment tools proceeds in parallel with, that is, feeds and is fed by, further efforts to develop a more comprehensive theory of multiple-documents literacy.

Despite these limitations, we remain enthusiastic about our current contribution because it may initiate a line of research that will provide interesting and much needed insights into how contextual and individual factors interact to determine how readers in and out of school are able to deal with the large overflow of information sources characterizing present-day knowledge societies.

CAPÍTULO 5

Conclusiones Generales

La comprensión de uno o varios textos depende, al menos, de variables relacionadas con el texto, con el lector, y con el contexto de lectura. Aunque tal afirmación pueda parecernos obvia, no siempre se ha considerado de este modo. Así, el estudio de la comprensión de textos pasó por un largo periodo en el que primaban los análisis relacionados con el contenido textual como único determinante de la comprensión lectora. Fue más adelante, en la década de los 80, cuando las teorías hoy ya tradicionales de comprensión pusieron de manifiesto el significativo papel que juegan las características del lector en la comprensión de textos, reconociéndose desde entonces la importancia de los conocimientos que el lector ya posee como condicionante de lo que puede aprender. El modelo de Construcción-Integración de Kinstch (1988, 1998) descrito en el marco teórico de esta investigación es un buen ejemplo de estas teorías. De acuerdo con los supuestos de este modelo, la comprensión lectora no implica únicamente la construcción de la representación mental del contenido textual (texto base), sino que el lector añade a ésta la

construcción de una representación mental integrada con las estructuras de su conocimiento previo (modelo de la situación).

Sin embargo, no solamente la información que contiene el texto, o lo que el lector sabe, sino también lo que *hace* cuando intenta comprender influyen en el resultado final. Cualquier tarea de lectura o escritura involucra el uso de estrategias y procesos específicos que determinan lo que el sujeto comprende finalmente. Por ende, el aprendizaje del contenido textual que el lector alcance tras la lectura, dependerá también del propósito de la tarea de lectura en el que está envuelto y de los procesos y estrategias que ponga en marcha para resolverla. En la comprensión a partir de documentos múltiples esta afirmación es incluso más relevante que en la comprensión de un texto único, ya que el abanico de tareas a los que los lectores pueden enfrentarse es amplísimo y, consecuentemente, el conjunto de estrategias y procesos mentales diferentes que ponen en marcha para resolverlas también lo es.

Pero la complejidad del problema no acaba aquí. Las variables textuales, del lector y del contexto de tarea no ejercen su efecto independientemente sino que pueden interactuar entre ellas, de forma que niveles concretos de una variable pueden moderar los efectos de otra variable y viceversa. Así, la investigación en comprensión de textos nos ha mostrado que, por ejemplo, el nivel de conocimiento previo de los estudiantes modera el efecto del tipo de preguntas que los estudiantes resuelven para aprender información. Mientras los lectores con alto conocimiento previo se benefician de las preguntas literales, los lectores con bajo conocimiento previo lo hacen de las preguntas inferenciales (Vidal-Abarca, Gilabert y Rouet, 2005).

En los capítulos que se incluyen en esta tesis, hemos examinado las interacciones que surgen durante la lectura de documentos múltiples entre variables pertenecientes a dos de las grandes áreas que se acaban de describir: las características del contexto de tarea y las características personales de los lectores que las llevan a cabo. Como el lector habrá notado a estas alturas, el orden que

siguen los capítulos no es casual sino que se corresponde con el orden en el que fueron realizados los estudios experimentales que presentan cada uno de ellos. Los estudios fueron planeados partiendo de un objetivo inicial que abordamos directamente en el capítulo 3, i.e. examinar el efecto de la tarea (ensayo argumentativo vs. resumen) en la comprensión e integración de varios documentos acerca del cambio climático y su interacción con la epistemología personal de los estudiantes acerca del tema de estudio. Para conseguir este objetivo, primeramente consideramos necesario examinar la dimensionalidad de las creencias epistemológicas de los estudiantes a nivel de conceptos científicos específicos (capítulo 2). Los resultados obtenidos en el experimento que presenta el capítulo 3, relativos a la ausencia del efecto beneficioso de la tarea de argumentación en la comprensión e integración de los estudiantes, motivaron la realización de dos nuevos experimentos diseñados para explicar estos inesperados resultados. En estos experimentos examinamos los efectos de dos variables independientes que no habían sido contempladas previamente, el modo de presentación de la información textual y el conocimiento previo de los estudiantes (capítulo 4).

A partir de los resultados obtenidos en esta serie de estudios, se pueden formular varias conclusiones generales. La primera de ellas se deduce de nuestro primer estudio, que tenía como objetivo explorar empíricamente la dimensionalidad de la epistemología personal a nivel de conceptos científicos específicos. El análisis factorial realizado sobre las puntuaciones del cuestionario TSEBQ de los estudiantes españoles y noruegos que participaron en el estudio ofrece nuevos datos que corroboran la complejidad dimensional de las creencias epistemológicas y el ajuste del Modelo de Hofer y Pintrich (1997) para explicar cómo se estructuran las creencias epistemológicas a este nivel de especificidad, un asunto que apenas ha sido abordado en la literatura hasta el momento.

Por un lado, el análisis factorial realizado con las puntuaciones de los estudiantes españoles reveló la existencia de cuatro factores significativos, designados como: Certeza del conocimiento—Provisionalidad, Certeza del conocimiento—Ambigüedad, Fuente del Conocimiento y Justificación del Conocimiento. Como sabemos, los ítems del cuestionario fueron elaborados siguiendo las dimensiones de Certeza, Simplicidad, Fuente de Conocimiento y Justificación propuestas por Hofer y Pintrich en su modelo teórico. Así, mientras las dos dimensiones relativas al proceso de adquisición del conocimiento, i.e. Fuente de conocimiento y Justificación del conocimiento emergieron como factores significativos en el análisis realizado con población española, observamos ciertas diferencias en los factores relativos a la naturaleza del conocimiento. Esto es, el factor Simplicidad propuesto en el modelo no apareció como factor diferencial, y el factor Certeza apareció, sin embargo, disgregado en dos factores, uno relativo a la estabilidad del conocimiento y otro relativo a la ambigüedad del conocimiento.

Por otro lado, en el estudio paralelo realizado con estudiantes noruegos, el análisis factorial arrojó una estructura de cuatro factores coincidentes con las cuatro dimensiones propuestas por Hofer y Pintrich en su modelo. Por tanto, a nivel general, los resultados de ambos estudios confirman empíricamente el modelo multidimensional propuesto por Hofer y Pintrich a nivel de conceptos específicos, y sugieren que dicho modelo puede ser empleado para evaluar las creencias epistemológicas de los universitarios a nivel de conceptos específicos.

Una segunda conclusión que también se deduce de nuestro primer estudio es que la cultura influye en la dimensionalidad de las creencias epistemológicas. Aunque los resultados obtenidos en los análisis factoriales de las dos culturas evaluadas confirmaron a nivel general la transculturalidad de las dimensiones, se observaron ciertas diferencias entre las dos estructuras factoriales obtenidas. Así, mientras que nuestro estudio empírico replica las dos dimensiones sobre el proceso de adquisición

de conocimiento del modelo de Hofer y Pintrich (i.e. Fuente y Justificación del conocimiento), las dimensiones relativas a la naturaleza del conocimiento sólo se replican parcialmente. Una posible explicación a este resultado podría ser que las creencias de los estudiantes acerca de la adquisición del conocimiento de los estudiantes son más generales, i.e. menos dependientes de contenidos o conceptos concretos, que las creencias sobre la naturaleza del conocimiento. Las diferencias encontradas con respecto a las dimensiones relativas a la naturaleza del conocimiento podrían estar relacionadas con que el conocimiento acerca del cambio climático ha recibido un tratamiento diferente, tanto a nivel educativo como público, en los dos países estudiados provocando concepciones diferentes acerca de la naturaleza del mismo. Esta interpretación viene avalada por otros estudios realizados en Asia (e.g., Chan y Elliot, 2002) y Europa (e.g., Bråten y Strømsø, 2005; Clarebout, Elen, Luyten, y Bamps, 2001) que muestran estructuras factoriales diferentes a las expuestas por los estudios tradicionales realizados en Norteamérica, confirmando en papel de la cultura en algunos aspectos de la dimensionalidad de las creencias epistemológicas.

Una tercera conclusión general es que el tipo de tareas que los estudiantes resuelven para comprender e integrar información de varios textos no tiene un efecto simple y directo sino complejo y dependiente de su interacción con otras variables. La literatura existente hasta el momento, aunque con resultados no concluyentes, parecía mostrarnos que las tareas argumentativas eran más adecuadas que los resúmenes para promover la comprensión e integración de los estudiantes y, de hecho, éste fue el sentido en el que formulamos las hipótesis de nuestros experimentos. Sin embargo, los resultados de nuestros experimentos nos mostraron que esta asunción no se cumple en todos los casos. Así, las tareas argumentativas no son tareas cuyo efecto resulta óptimo para todos los estudiantes sino que depende, al menos, de su interacción con otras variables.

Una de estas variables es el conocimiento previo. Parece que si los estudiantes tienen bajo conocimiento previo del tema que presentan los textos, las tareas de resumen pueden ayudarles a comprender e integrar la información de los textos en mayor medida que las tareas argumentativas. El beneficio de la tarea de resumen sobre las tareas argumentativas se observa tanto en la ejecución de cuestionarios que miden la comprensión superficial del contenido de cada uno los textos, como en aquellos que suponen una comprensión más profunda e implican la integración de información de las diferentes fuentes. Así mismo, se observa en la calidad de sus composiciones escritas, mostrando los resúmenes un mayor grado de transformación e integración de la información que las tareas argumentativas. Sin embargo, cuando los lectores tienen alto conocimiento del tema son las tareas argumentativas las que parecen beneficiarles. Los lectores con alto conocimiento previo obtuvieron mejores resultados cuando leyeron los textos para escribir un ensayo argumentativo que cuando lo hicieron para escribir un resumen.

De hecho, en los tres experimentos descritos en esta tesis, cuando los lectores tenían bajo conocimiento del tema de los textos (i.e. cambio climático), los resúmenes produjeron mejores resultados que las tareas argumentativas, independientemente de si resolvieron la tarea con la información proveniente de siete o de cinco textos y de si leyeron los textos en papel o lo hicieron en la pantalla de un ordenador. Sin embargo, en el único caso en que contamos con una muestra de estudiantes con conocimiento previo alto, encontramos el efecto opuesto, las tareas argumentativas ofrecieron los mejores resultados. Es posible que sea necesario que los estudiantes posean cierto nivel de conocimiento previo para poder cumplir con las demandas de las tareas argumentativas, y poder así beneficiarse de los efectos que se les ha atribuido en investigaciones previas. Esto es, para que las tareas argumentativas puedan ejercer su efecto sobre la comprensión de los estudiantes, se requiere que los estudiantes las resuelvan correctamente. Para resolver correctamente una tarea argumentativa, han

de ser capaces de formarse su propia opinión acerca del tema que tratan los textos y de apoyar esta opinión con argumentos basados en el contenido de los textos. Si no cuentan con cierta información previa, parece difícil que puedan desenvolverse en este tipo de procesamiento. Esta interpretación coincide con la teoría de la flexibilidad cognitiva formulada por Spiro, Coulson, Feltovich, y Anderson (1994) en la que postularon que es necesario que los estudiantes posean cierto conocimiento previo acerca del tema de estudio para que puedan beneficiarse de las tareas que implican atender a puntos de vista dispares presentados en diferentes fuentes de información.

Así mismo, es posible que las tareas de resumen requieran un procesamiento menos exigente y que se adapten mejor a los estudiantes con bajo conocimiento previo. En este sentido, investigaciones previas han mostrado que los estudiantes con poco conocimiento previo acerca del tema de estudio se benefician más de las tareas que no les son demasiado difíciles y se adaptan a sus recursos de procesamiento (McNamara, 1996). No obstante, que el resumen sea una tarea a priori más fácil, no implica que conlleve un procesamiento superficial de los textos. De hecho, varios estudios han mostrado que los resúmenes son buenas herramientas para promover la comprensión y el procesamiento profundo de la información textual (Bransford, Brown y Cocking, 2000; Wade-Stein y Kintsch, 2004). Idealmente, los resúmenes implican además de la selección de la información más importante, la transformación de la información textual en una representación coherente e integrada con los conocimientos del lector.

Por tanto, parece que el conocimiento previo que tienen los estudiantes acerca del tema que tratan los textos podría explicar, al menos en parte, las discrepancias encontradas entre los resultados de los diferentes estudios que comparan el efecto de las tareas y los resúmenes en la comprensión e integración de información presentada en documentos múltiples (Le Bigot y Rouet, 2007; Wiley y Voss, 1999). Sin embargo, no podemos apoyar con datos empíricos esta afirmación porque, lamentablemente,

desconocemos el nivel de conocimiento previo del que disponían los participantes de estos estudios.

Otra de las variables que caracterizan al lector y que parece interaccionar con el tipo de tarea al que se enfrentan los sujetos durante la lectura de documentos múltiples son las creencias epistemológicas que poseen los estudiantes acerca del tema de estudio. Nuestra hipótesis de partida al respecto fue que los estudiantes con creencias epistemológicas sofisticadas se beneficiarían más de las tareas argumentativas que los estudiantes con creencias más ingenuas. Esta hipótesis sólo recibió cierto apoyo de los resultados obtenidos en el experimento que incluye el capítulo 3. En concordancia con Bråten, y Strømsø (2006a) encontramos que el efecto de la tarea sobre la comprensión intratextual de los estudiantes era moderado por el nivel de sus creencias epistemológicas acerca del cambio climático. Concretamente, encontramos que los estudiantes con creencias ingenuas acerca de la certeza del conocimiento vieron especialmente perjudicada su comprensión intratextual cuando leyeron los textos con la instrucción de realizar un ensayo argumentativo, en lugar de hacerlo con la instrucción de realizar un resumen. Sin embargo, los estudiantes con creencias más sofisticadas obtuvieron niveles similares de comprensión en las dos condiciones de tarea. Es posible que las creencias sofisticadas compensaran de algún modo el bajo conocimiento previo con el que los estudiantes se enfrentaron a la tarea argumentativa. Esto es, el hecho de creer que el conocimiento acerca del cambio climático es relativo y rebatible y no que el conocimiento se compone de verdades absolutas e indiscutibles les ayudó a adaptar su procesamiento a las demandas de la tarea argumentativa. Este interpretación coincide con las conclusiones alcanzadas por Pieschl, Stahl y Bromme (2008) referentes a que los estudiantes con creencias sofisticadas son más capaces de autorregular su aprendizaje en relación con las demandas de la tarea que los estudiantes con creencias ingenuas.

Una razón adicional que podría explicar el hecho de que los participantes de nuestros estudios con bajo conocimiento previo acerca del cambio climático no se beneficiaran de las tareas argumentativas es la escasa experiencia que suelen tener los estudiantes formados bajo los patrones del sistema educativo español en la práctica de este tipo de tareas. Creemos que entrenar a los estudiantes en el empleo de las estrategias adecuadas para escribir ensayos argumentativos como las estrategias de corroboración o las que implican atención a las fuentes, podría ayudarles a beneficiarse de las tareas argumentativas, a pesar de que poseyeran un nivel bajo de conocimiento previo. Así, se ha demostrado que el entrenamiento en este tipo de estrategias produce mejoras significativas en la comprensión de los estudiantes (Britt y Angliskas, 2000).

Para concluir, quisiéramos resaltar algunas de las implicaciones educativas de nuestra investigación. En primer lugar, creemos que el conocimiento de la estructura dimensional de las creencias epistemológicas a nivel de conceptos específicos, facilitará la elaboración de instrumentos de medida que evalúen el estado de las creencias epistemológicas de nuestros estudiantes ofreciendo al docente y otros profesionales información útil acerca de, por ejemplo, la opinión de sus estudiantes sobre la credibilidad de los conocimientos que imparte sobre un concepto específico o cuáles son los criterios que emplean para justificar las afirmaciones relativas a ese mismo concepto. Además, al limitar el contexto al que las creencias hacen referencia eliminamos una fuente indeseable de varianza. Al mismo tiempo, el hecho de examinar las creencias epistemológicas de forma mas contextualizada concuerda con investigaciones recientes del área de la psicología educativa que han mostrado y destacado el efecto de los factores contextuales en la motivación y el aprendizaje de los estudiantes (p.ej., Bandura, 1997; Bransford, Brown, y Cocking, 2000).

En segundo lugar, hemos incrementado el conocimiento existente acerca del efecto de las tareas de integración sobre la comprensión y de la interacción de éstas

con ciertas características del lector. Por tanto, el profesor dispone desde este momento de información relevante acerca de cuáles son las tareas que puede emplear para que sus alumnos aprendan con documentos múltiples, y acerca de a qué características personales de sus alumnos debe prestar atención para la correcta selección e implementación de las tareas en clase. Así, deberá tener en cuenta, por ejemplo, que si decide trabajar con documentos múltiples acerca de un concepto novedoso para sus estudiantes, las tareas argumentativas no serán siempre las más adecuadas para promover su comprensión. El conocimiento previo de sus estudiantes acerca del tema que pretende enseñar puede no ser suficiente para llevar a cabo tareas argumentativas y por ello, deberá planear actividades alternativas. Una buena opción podría ser pedir a sus estudiantes que hicieran un resumen que integrara la información de los diferentes textos antes de pedirles que se formen su propia opinión. Así mismo, deberá tener en cuenta el nivel de dominio de las estrategias específicas para el empleo de documentos múltiples que muestren sus estudiantes, así como el grado de sofisticación de su creencias epistemológicas acerca del tema de estudio, ya que éstas son variables que podrán contribuir al aprendizaje que alcancen los estudiantes.

No obstante, queremos dejar constancia de una limitación general de nuestro estudio, esto es, que los resultados de todos ellos así como las conclusiones alcanzadas se limitan al concepto que tratan los textos y los cuestionarios empleados, i.e. cambio climático. Son, por tanto, necesarios nuevos estudios que analicen si nuestros resultados son generalizables a otros conceptos.

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Appendixes

Appendix A. Topic knowledge measure.

Appendix B. Topic interest measure.

Appendix C. Personal epistemology measure.

Appendix D. Texts.

Appendix E. Sentence verification task (SVT).

Appendix F. Intratextual inference verification task (IntraVT).

Appendix G. Intertextual inference verification task (InterVT).

Appendix H. Oral instructions.

Appendix I: Task instruction: Argument essay

Appendix J: Task instruction: Summary

APPENDIX A

TOPIC KNOWLEDGE MEASURE

A continuación encontrarás una serie de preguntas con afirmaciones sobre temas importantes relacionados con la naturaleza y el medio ambiente. Rodea la frase que consideras correcta en cada pregunta.

1. El protocolo de Kyoto tiene que ver con
   a) acuerdos comerciales entre países ricos y pobres
   b) reducción de las emisiones de los gases de efecto invernadero
   c) la contaminación del Océano Pacífico
   d) la protección de la capa de ozono
   e) limitaciones para la pesca de ballenas a nivel internacional

2. El efecto invernadero es debido a
   a) agujeros en la capa de ozono
   b) incremento en el uso de la energía nuclear
   c) aumento de la lluvia ácida
   d) flujos de calor que no salen de la atmósfera
   e) la contaminación en los océanos

3. Las emisiones de dióxido de carbono (CO_2) provocadas por el hombre son debidas al uso de
   a) propulsores (clorofluorocarbonos) de latas de aerosol
   b) fertilizantes para el cultivo
   c) detergentes con fosfatos
   d) combustibles fósiles
   e) energía atómica

4. La investigación indica que la temperatura media de la tierra
   a) ha aumentado más de 5 °C en los últimos 100 años
   b) ha aumentado más de 5 °C en los últimos 10 años
   c) ha aumentado menos de 1 °C en los últimos 100 años
   d) ha aumentado más de 10 °C en los últimos 100 años
   e) se encuentra en proceso de estabilización

5. Algunos de los gases de efecto invernadero más importantes son
   a) cloro e hidrógeno
   b) oxígeno y propano
   c) óxidos de nitrógeno y butano
   d) propulsores y aerosoles
   e) vapor de agua y gas de la risa

6. Una consecuencia del calentamiento global puede ser
   a) un descenso en la actividad industrial de las regiones nórdicas
   b) mejores condiciones para el cultivo en países en vías de desarrollo
   c) un acceso más fácil a los depósitos de petróleo y de gas en las regiones nórdicas
   d) mayor actividad petrolífera en regiones tropicales
   e) menos posibilidad de extraer oro y diamantes en las regiones nórdicas

7. El clima de la tierra ha cambiado
   a) debido a condicionantes astronómicos
   b) debido a cambios en la circunferencia de la tierra en el ecuador
   c) sobre todo debido al aumento de las emisiones de gas ozono
   d) debido a la reducción de las emisiones de gas ozono
   e) porque ha aumentado la intensidad de las corrientes oceánicas

8. La concentración de dióxido de carbono (CO_2) en la atmósfera
   a) varía entre grados altos y bajos de longitud terrestre
   b) varía muy poco de un sitio a otro
   c) es la más alta en las regiones industrializadas
   d) es la más alta en las regiones polares
   e) varía mucho de un sitio a otro

9. El efecto invernadero
   a) es ante todo un proceso natural
   b) está causado por el hombre
   c) es un fenómeno relativamente nuevo
   d) alcanza el nivel más alto en la estratosfera
   e) tiene su nivel más alto en las regiones industrializadas del planeta

10. El cambio climático global puede
   a) llevar a una bajada del nivel de los océanos
   b) llevar a un tiempo menos extremo en toda la Tierra
   c) influir en las corrientes oceánicas
   d) llevar a un aumento de la actividad volcánica
   e) llevar a que más energía solar escape de la atmósfera

11. Los gases de efecto invernadero
   a) no se encuentran naturalmente en la atmósfera
   b) son necesarios para gran parte de la vida en la tierra
   c) no existían en épocas pre-industriales
   d) son exclusivamente combinaciones sintéticas
   e) pueden causar la enfermedad de la legionela

12. Las emisiones humanas de dióxido de carbono (CO_2)
   a) pueden llevar a un aumento en la capa de ozono
   b) son reducidas substancialmente a través de las iniciativas ambientales internacionales
   c) son necesarias para la vida en la Tierra
   d) pueden modificar el equilibrio térmico de la Tierra
   e) introducen en la atmósfera la mayor parte de los gases de efecto invernadero

13. El protocolo de Kyoto
   a) es un acuerdo de obligado cumplimiento entre los E.E.U.U. y la U.E.
   b) es un acuerdo de obligado cumplimiento gestionado por la Organización Mundial de Comercio (WTO)
   c) es un acuerdo internacional de obligado cumplimiento gestionado por la ONU
   d) ha sido ratificado por todos los grandes países industrializados
   e) es un acuerdo importante sobre el almacenamiento de los desechos radioactivos

14. Las actividades humanas
    a) son la base del efecto invernadero
    b) intensifican el efecto invernadero
    c) han aumentado la cantidad de ozono en la estratosfera
    d) han hecho que la tierra se asemeje a un invernadero
    e) pueden influir en la radiación solar

15. La temperatura media de la Tierra aumenta
    a) por un aumento en la temperatura del núcleo de la Tierra
    b) por los cambios en el reflejo de la luz del Sol en la Luna
    c) por la disminución de nubes en la atmósfera
    d) por el aumento en las emisiones de gases de efecto invernadero
    e) porque las radiación de calor del sol penetra más fácilmente hacia la superficie de la tierra

16. El efecto invernadero se intensifica por
    a) el aumento en el uso de combustibles fósiles
    b) la radiación de calor procedente del sol
    c) agujeros en la capa de ozono
    d) el aumento de plantaciones en las regiones tropicales
    e) el aumento del cultivo de plantas modificadas genéticamente

17. El cambio climático puede llevar a
    a) más tierras cultivables en áreas desérticas
    b) reducir las diferencias en la producción agrícola entre diversas partes del mundo
    c) una importante reducción en la producción mundial de alimento
    d) condiciones más estables para el cultivo en áreas costeras
    e) mayores diferencias en la producción agrícola entre diversas partes del mundo

APPENDIX B

TOPIC INTEREST MEASURE

Con las siguientes frases queremos saber en qué medida estás interesado y comprometido en las cuestiones relacionadas con la naturaleza y el medio ambiente. Si estás totalmente de acuerdo con la frase rodea el 10; si estás completamente en desacuerdo rodea el 1. Si estás más o menos de acuerdo con la frase marca el número entre 1 y 10 que mejor describa tu interés y compromiso.

		Muy en desacuerdo									**Muy de acuerdo**
1	Estoy interesado en la política ambiental internacional.....	1	2	3	4	5	6	7	8	9	10
2	Estoy interesado en temas relacionados con el clima de la Tierra.....	1	2	3	4	5	6	7	8	9	10
3	Pienso que debería haber más gente comprometida activamente en la protección del medio ambiente.....	1	2	3	4	5	6	7	8	9	10
4	Participo en debates sobre temas relacionados con la naturaleza y el medio ambiente….....	1	2	3	4	5	6	7	8	9	10
5	Estoy interesado en los factores que influyen en el clima de la Tierra.....	1	2	3	4	5	6	7	8	9	10
6	Puedo imaginarme como miembro de una organización dedicada a la protección de la naturaleza y el medio ambiente.....	1	2	3	4	5	6	7	8	9	10
7	El calentamiento global es un tema que me interesa….....	1	2	3	4	5	6	7	8	9	10
8	Me preocupo por cómo yo mismo puedo contribuir a reducir la contaminación ambiental.....	1	2	3	4	5	6	7	8	9	10
9	Trato de convencer a otras personas de que debemos reducir las emisiones de gases de efecto invernadero…..	1	2	3	4	5	6	7	8	9	10
10	Estoy interesado en temas relacionados con la contaminación atmosférica.....	1	2	3	4	5	6	7	8	9	10
11	Apoyo a las organizaciones que trabajan para reducir el calentamiento global.....	1	2	3	4	5	6	7	8	9	10
12	Me gusta estar al día en temas relacionados con el cambio climático.....	1	2	3	4	5	6	7	8	9	10

APPENDIX C

PERSONAL EPISTEMOLOGY MEASURE

Los temas relacionados con el clima son de gran actualidad y frecuentemente se habla de ellos en los medios de comunicación. Frecuentemente, podemos leer informaciones sobre el cambio climático, la contaminación atmosférica, el calentamiento de la Tierra, temperaturas extremas, el aumento del nivel de agua en los océanos, y el derretimiento del hielo en las regiones polares. Noticias sobre estos temas salen a menudo en periódicos y revistas, así como en la televisión o en la radio. La mayoría de científicos que estudian el clima tienen formación en ciencias tales como química, biología, o meteorología. Las siguientes preguntas hacen referencia a conocimientos sobre el clima y a cómo uno llega a adquirir conocimientos acerca del clima. No hay respuestas corrrectas ni incorrectas a estas preguntas; son tus creencias personales lo que nos interesa conocer. Utiliza la escala que verás abajo para contestar a las preguntas. Si estás completamente de acuerdo con una frase, rodea el 10; si estás totalmente en desacuerdo marca el 1. Si estás más o menos de acuerdo con una frase, rodea el número entre 1 y 10 que mejor exprese tu creencia.

		Totalmente en desacuerdo									**Totalmente de acuerdo**
1.	Los investigadores del clima pueden descubrir la verdad sobre casi todo lo referente al clima.....	1	2	3	4	5	6	7	8	9	10
2.	Cuando leo sobre temas relacionados con el clima, la opinión del autor es más importante que la mía.....	1	2	3	4	5	6	7	8	9	10
3.	Con respecto a los problemas sobre el clima, siento que me muevo en terreno seguro únicamente si encuentro una afirmación de un experto.....	1	2	3	4	5	6	7	8	9	10
4.	En la investigación sobre el clima, los hechos son más importantes que las teorías.....	1	2	3	4	5	6	7	8	9	10
5.	El conocimiento sobre temas relacionados con el clima cambia constantemente.....	1	2	3	4	5	6	7	8	9	10
6.	Cuando leo sobre temas relacionados con el clima, confío sobre todo en mi propia percepción sobre lo que es correcto.....	1	2	3	4	5	6	7	8	9	10
7.	En la investigación sobre el clima , existe acuerdo sobre lo que es cierto.....	1	2	3	4	5	6	7	8	9	10
8.	Sólo creo lo que leo sobre temas relacionados con el clima si está de acuerdo con mis propias observaciones.....	1	2	3	4	5	6	7	8	9	10
9.	Con respecto a los temas relacionados con el clima, para mí es más importante que el punto de vista sea bueno que la forma en que uno ha llegado al mismo...	1	2	3	4	5	6	7	8	9	10

		Totalmente en desacuerdo									**Totalmente de acuerdo**
10.	Con respecto al conocimiento sobre el clima, raramente existen conexiones entre temas diferentes.	1	2	3	4	5	6	7	8	9	10
11.	En la investigación sobre el clima, el conocimiento preciso de los detalles es lo más importante.....	1	2	3	4	5	6	7	8	9	10
12.	Cuando leo sobre los problemas del clima, confío en los resultados de las investigaciones científicas más que en el punto de vista de la gente común y corriente.....	1	2	3	4	5	6	7	8	9	10
13.	El conocimiento sobre el clima consiste en ideas esenciales más que en detalles.....	1	2	3	4	5	6	7	8	9	10
14.	No existe un método que yo pueda emplear para decidir si afirmaciones de textos sobre temas relacionados con el clima son fiables.....	1	2	3	4	5	6	7	8	9	10
15.	La gente común y corriente no tiene ninguna base para hablar sobre temas relacionados con el clima.....	1	2	3	4	5	6	7	8	9	10
16.	En la investigación sobre el clima, la verdad no cambia.....	1	2	3	4	5	6	7	8	9	10
17.	Comprendo mejor los temas relacionados con el clima cuando pienso sobre ellos por mí mismo, y no me limito a leer sobre ellos.....	1	2	3	4	5	6	7	8	9	10
18.	Para comprender los problemas del clima, no es suficiente con leer lo que los expertos han escrito sobre esos problemas.....	1	2	3	4	5	6	7	8	9	10
19.	Cuando leo sobre temas relacionados con el clima, lo que me inspira más confianza son las afirmaciones basadas en investigaciones científicas.....	1	2	3	4	5	6	7	8	9	10
20.	En la investigación sobre el clima, tener varias teorías sobre el mismo asunto hará las cosas innecesariamente complicadas.....	1	2	3	4	5	6	7	8	9	10
21.	El conocimiento sobre temas relacionados con el clima está reservado a los expertos.....	1	2	3	4	5	6	7	8	9	10
22.	El conocimiento sobre el clima consiste en conceptos bien relacionados entre sí más que en una acumulación de hechos aislados.....	1	2	3	4	5	6	7	8	9	10
23.	Para averiguar si lo que leo sobre los problemas del clima es digno de confianza, intento comparar conocimientos de fuentes diferentes.....	1	2	3	4	5	6	7	8	9	10

		Totalmente en desacuerdo									Totalmente de acuerdo
24.	En la investigación sobre el clima, muchas cosas están relacionadas.....	1	2	3	4	5	6	7	8	9	10
25.	Cuando leo sobre problemas del clima, tengo la máxima confianza en las ideas que confirman lo que he visto con mis propios ojos.....	1	2	3	4	5	6	7	8	9	10
26.	Mis ideas personales sobre los problemas del clima, tienen poco valor en comparación con lo que puedo aprender sobre ellos en libros y artículos.....	1	2	3	4	5	6	7	8	9	10
27.	A menudo me da la impresión de que debo limitarme a confiar en lo que leo sobre los problemas del clima	1	2	3	4	5	6	7	8	9	10
28.	Las teorías sobre el clima pueden ser refutadas en cualquier momento.....	1	2	3	4	5	6	7	8	9	10
29.	Cuando leo sobre los problemas del clima, me ciño a lo que el texto dice expresamente.....	1	2	3	4	5	6	7	8	9	10
30.	Para poder confiar en afirmaciones de textos sobre temas relacionados con el clima, uno tiene que comprobar varias fuentes de conocimiento.....	1	2	3	4	5	6	7	8	9	10
31.	El conocimiento sobre los problemas del clima es incuestionable.....	1	2	3	4	5	6	7	8	9	10
32.	La finalidad principal cuando se lee sobre los problemas del clima es formarse una opinión personal sobre ellos.....	1	2	3	4	5	6	7	8	9	10
33.	El conocimiento sobre el clima se caracteriza, sobre todo, por una gran cantidad de información de detalle.	1	2	3	4	5	6	7	8	9	10
34.	El conocimiento cierto y seguro sobre el clima es algo poco común.....	1	2	3	4	5	6	7	8	9	10
35.	En la investigación sobre clima, el conocimiento consiste principalmente en una acumulación de hechos.....	1	2	3	4	5	6	7	8	9	10
36.	En la investigación sobre el clima, hay conexiones entre muchos temas.....	1	2	3	4	5	6	7	8	9	10
37.	En la investigación sobre el clima, el conocimiento es complejo.....	1	2	3	4	5	6	7	8	9	10
38.	Los resultados de la investigación sobre el clima son provisionales.....	1	2	3	4	5	6	7	8	9	10

		Totalmente en desacuerdo									**Totalmente de acuerdo**
39.	En los temas relacionados con el clima, las actitudes son más importantes que los métodos científicos.....	1	2	3	4	5	6	7	8	9	10
40.	Para lograr verdadera comprensión sobre los temas relacionados con el clima, uno ha de formarse su propia opinión personal de lo que lee.....	1	2	3	4	5	6	7	8	9	10
41.	Los problemas en la investigación sobre el clima carecen de una solución clara e inequívoca.....	1	2	3	4	5	6	7	8	9	10
42.	Mi propia comprensión de temas relativos al clima es por lo menos tan importante como el conocimiento que hay sobre ellos en los textos.....	1	2	3	4	5	6	7	8	9	10
43.	Lo único que sabemos con seguridad sobre los problemas del clima, es que nada es seguro.....	1	2	3	4	5	6	7	8	9	10
44.	Cuando leo sobre temas relacionados con el clima, evalúo si el contenido tiene lógica.....	1	2	3	4	5	6	7	8	9	10
45.	Lo que hoy se considera conocimiento cierto acerca del clima, mañana puede ser considerado falso.....	1	2	3	4	5	6	7	8	9	10
46.	Los conocimientos sobre el clima hacen referencia a principios y conceptos más que a hechos.....	1	2	3	4	5	6	7	8	9	10
47.	La investigación sobre el clima demuestra que la mayoría de los problemas en ese área tienen una respuesta correcta.....	1	2	3	4	5	6	7	8	9	10
48.	Para comprobar si lo que leo acerca de los problemas del clima es fiable, intento evaluarlo comparándolo con otras cosas que he aprendido sobre el tema.....	1	2	3	4	5	6	7	8	9	10
49.	Cuando leo sobre temas relacionados con el clima, intento llegar a una comprensión personal del contenido.....	1	2	3	4	5	6	7	8	9	10

APPENDIX D

MULTIPLE TEXTS

EL CALENTAMIENTO GLOBAL

Texto del libro de texto de Ciencias Naturales de Bachillerato de M. Fernández, T. Estrada y V. Domínguez (2004), Cosmos. Madrid: Triados.

El clima de la tierra ha ido variando a lo largo del tiempo. Hasta hace poco, estos cambios climáticos se debían a causas naturales, tales como cambios en la fuerza del sol, cambios en la órbita de la tierra alrededor del sol, y erupciones volcánicas. Ahora parece que por primera vez, la humanidad se enfrenta a un cambio climático global causado por sus propias actividades.

El efecto invernadero natural:

El efecto invernadero es, ante todo, un proceso natural y necesario. El sol tiene en su superficie una temperatura de aproximadamente 6000 Cº y emite varios tipos de radiación. La mitad de los rayos solares que impactan en la atmósfera de la tierra penetran hasta la superficie de la tierra, el resto son reflejados por nubes y otros gases. La mayor parte de los rayos solares que llegan a la tierra tienen longitudes de onda cortas. Estos calientan la superficie de la tierra, que devuelve flujos de calor de longitud de onda larga. Una gran proporción de estos flujos devueltos por la tierra son absorbidos por las nubes y los gases de la atmósfera, los cuales devuelven el calor irradiado nuevamente a nosotros.

Algunos de estos gases de la atmósfera reciben el nombre de gases de efecto invernadero. Los gases de efecto invernadero más importantes son el vapor de agua, el dióxido de carbono y el metano. Estos gases forman un escudo térmico que reduce la radiación de calor que emite la tierra. Esto da lugar a que la superficie de la tierra y la capa del aire que la rodea aumenten su temperatura. Esto mismo ocurre en un invernadero, donde los rayos de sol penetran a través de los paneles de cristal, pero el flujo de calor irradiado es retenido en su salida. El resultado es que el interior del invernadero está más caliente que el exterior. Sin este efecto invernadero natural, la temperatura media de la tierra sería de -18ºC en lugar de 15ºC que es la temperatura media de la tierra en la actualidad.

El efecto invernadero de origen humano:

Recientemente, los científicos del clima han descubierto que la temperatura media de la tierra ha aumentado aproximadamente 0.5°C entre 1850 y 2004. Desde alrededor del 1900 hasta hoy, el nivel del dióxido de carbono en el aire se ha incrementado desde menos del 0,03% hasta casi el 0,04%, y parece que este incremento continua. Esto se debe al hecho de que hemos aumentado nuestras emisiones de CO2 a la atmósfera por la combustión de grandes cantidades de petróleo, gas y carbón.

Las actividades humanas también han dado lugar a aumentos en las emisiones de otros gases de efecto invernadero. Esto puede provocar que más flujo de calor sea retenido cuando escapa de la tierra y que la temperatura media aumente todavía más.

EL EFECTO INVERNADERO DE ORIGEN HUMANO

CICERO. Centro Internacional de investigación sobre el Clima y el Medio Ambiente. Universidad de Oslo.
http://www.cicero.uio.no/abc/klimaendringer.html
8 de Febrero de 2005

La comisión sobre el clima de la ONU concluye en su tercer informe del 2001 que es muy probable que las emisiones de gases de efecto invernadero de origen humano hayan contribuido significativamente al cambio climático observado en los últimos 30-50 años.

El efecto invernadero de origen humano:

Desde la época pre-industrial (alrededor de 1750) la concentración de dióxido de carbono (CO2) ha aumentado cerca de un 31 por cien, la concentración de metano (CH4) cerca de un 151 por cien y la concentración de óxido nitroso (N2O) ha aumentado cerca de un 17 por cien. Estos aumentos se deben a emisiones de origen humano y han dado lugar a un efecto invernadero más intenso. La actividad humana también ha introducido en la atmósfera pequeñas cantidades de algunos gases de efecto invernadero que no existen en la atmósfera de forma natural.

El aumento de la concentración de CO2 en la atmósfera constituye el primer componente (alrededor del 60%) de la intensificación del efecto invernadero del cual el hombre es responsable. Estas emisiones de CO2 de origen humano se deben en primer lugar y sobre todo al consumo de combustibles fósiles (carbón, petróleo y gas) y a la tala de árboles en las regiones tropicales.

Las emisiones de origen humano son solamente una parte pequeña de la cantidad de gases de efecto invernadero que son emitidos a la atmósfera y su efecto es de menor importancia si lo comparamos, por ejemplo, con el efecto del vapor de agua natural. El problema es que el sistema climático es muy complejo y sensible, e incluso pequeñas variaciones en el sistema pueden desencadenar importantes consecuencias. Las emisiones naturales de los gases de efecto invernadero forman parte de un ciclo en el cual, por ejemplo, los árboles en descomposición desprenden CO2 y los árboles vivos absorben el CO2 a través de la fotosíntesis. Nuestras emisiones de CO2 procedentes de, entre otras cosas, la quema de combustibles fósiles, no forman parte de este ciclo y dan como resultado un excedente de CO2 que permanece en la atmósfera durante un largo periodo.

¿PUEDE CAMBIAR EL CLIMA DEBIDO A CAUSAS NATURALES?

APOLO – Periódico de investigación de la Universidad de Barcelona
Profesor Eladio Gámez, Instituto de Astrofísica Teórica, Universidad de Barcelona
7 de Febrero de 2006

El clima siempre ha cambiado y continuará haciéndolo. Esto es una situación normal. Los cambios climáticos en la tierra están provocados en gran medida por condicionantes astronómicos. Por ejemplo, pequeños cambios en la órbita de la tierra alrededor del sol y cambios en la inclinación con respecto al eje rotatorio de la tierra – lo que hace que tengamos estaciones – se asocian a cambios climáticos significativos. Los cambios producidos entre las eras glaciares y períodos más cálidos están demostrablemente ligados a estos condicionantes astronómicos externos.

El sol afecta a la capa de nubes:

Sin el sol no tendríamos efecto invernadero, el cual es un prerrequisito para que nuestro planeta tenga condiciones habitables. Incluso pequeñas variaciones en la radiación solar afectan al clima. El sol es una estrella magnética y algunas zonas de su superficie tienen fuertes campos magnéticos. Estos afectan a su radiación y pueden ocasionar leves aumentos y disminuciones en la misma, y estos a su vez afectan al clima incluso en el caso de variaciones muy pequeñas.

Los campos magnéticos del sol rodean la tierra y otros planetas. Cuando las partículas procedentes de estrellas que previamente han explotado penetran en la atmósfera pueden afectar a la formación de nubes bajas. Esto a su vez tiene un efecto sobre el clima de la tierra. El campo magnético del sol, en grado variable, determinará la cantidad de partículas que penetren en nuestra atmósfera. Esto podría funcionar como un interruptor on/off para la capa de nubes alrededor de la tierra.

Se ha debatido mucho acerca del clima en los últimos años y a menudo la discusión ha girado en torno al grado en el que las actividades humanas están afectando a nuestro clima en comparación con los cambios naturales. Todavía no podemos afirmar que la contaminación humana de la atmósfera es la causa principal del cambio climático.

LAS CONSECUENCIAS NEGATIVAS DE UN EFECTO INVERNADERO MÁS INTENSO

LEVANTE – EL MERCANTIL VALENCIANO -
PERIODISTA GUSTAVO JIMÉNEZ
1 de Diciembre de 2004

Tormentas más fuertes, más huracanes y un tiempo atmosférico cada vez más tumultuoso son algunas de las consecuencias negativas que podemos esperar en los próximos años. El calentamiento global también puede debilitar la Corriente del Golfo y provocar un grave enfriamiento en el norte de Europa.

Algunos oceanógrafos temen por los efectos secundarios altamente perjudiciales del calentamiento global. Este puede debilitar las corrientes del Atlántico Norte hasta el punto de que hay un riesgo genuino de enfriamiento grave y duradero tanto de las Regiones Nórdicas como de gran parte de Europa y Norteamérica. Sin la Corriente del Golfo, las Regiones Nórdicas serían considerablemente más frías.

Los oceanógrafos son conscientes de que estos anuncios sorprenderán porque casi a diario se nos advierte de lo contrario, esto es, de que el calentamiento global aumentará la temperatura media de la tierra. Sin embargo, paradójicamente, ambas cosas podrían ocurrir al mismo tiempo. Si se altera la circulación del Atlántico, podríamos tener una caída en la temperatura media de entre 3 y 5 ° C. Esto tendrá un efecto dramático en la agricultura y la y en los bosques, mientras que al mismo tiempo habría una mayor necesidad de la calefacción.

Y hay indicios que revelan que estas alteraciones están en curso. Se está derritiendo más hielo debido al calentamiento global y se están produciendo más precipitaciones en Rusia, entre otros lugares. Esto está dando lugar a que los mayores ríos de Rusia descarguen crecientes cantidades de agua dulce en el Océano Ártico. Al mismo tiempo, existe el riesgo de perder el hielo del Ártico occidental y de Groenlandia.

Cuando se derrita el hielo que rodea los polos, no sólo se producirá un aumento en la masa de agua, sino que también se producirá un aumento en la evaporación de los océanos. Esto provocará huracanes con más energía. La Revista *Time* advierte que los huracanes han aumentado en número e intensidad desde 1995.

Según el Comité del clima de la ONU, un aumento del efecto invernadero dio lugar a que los niveles de agua se elevaran entre 10 y 20 centímetros durante el siglo pasado, y para 2100 los niveles de los océanos se elevarán entre 9 y 88 centímetros. Esto será catastrófico para muchas poblaciones costeras- especialmente en países en vías de desarrollo.

UN CLIMA CÁLIDO OFRECE NUEVAS OPURTUNIDADES

EL PAÍS.
PERIODISTA JUAN LLORCA
24 de Enero de 2006

Las regiones que ahora están siendo accesibles debido al calentamiento global esconden enormes riquezas. El derretimiento del hielo permite la explotación de recursos en las regiones nórdicas.

Según expertos de la ONU, las temperaturas alrededor del Polo Norte están aumentando a un ritmo doble que en otros lugares del mundo. El hielo del Ártico se está derritiendo tan rápidamente que para el verano de 2050 podría haber un pasillo marítimo accesible para barcos normales entre el Océano Atlántico y el Océano Pacífico que bordearía el norte de Canadá y Alaska, entre ambas zonas y el continente Ártico. Esta vía a través del Paso del Noroeste hacia Asia reducirá la distancia del viaje entre Londres y Tokio de 21.000 a 16.000 kilómetros.

Las Regiones Nórdicas que están siendo accesibles también esconden enormes riquezas. Se estima que los depósitos de petróleo y de gas que allí se esconden aumentarán un 30 por ciento los depósitos de la Tierra.

Y no sólo puede encontrarse petróleo en las regiones nórdicas. Hay también oro, diamantes, cobre y cinc. “Habrá mucho tráfico debido a esta exploración”, comenta Frederic Lasserre, un geógrafo de la Universidad Laval en Quebec (Canadá), especialista en las regiones del Ártico.

El director del Centro Nansen para el estudio del Medioambiente y la Detección Remota, también señala consecuencias positivas del calentamiento global, que tendrán lugar en el Ártico especialmente: - Un clima más cálido podría dar lugar a mejores condiciones de cultivo y a bajar los costes de la calefacción. El hielo del mar de Barents será empujado en dirección Norte y en dirección Este debido al aumento de los vientos del suroeste y a un clima más cálido. Esto ampliará las zonas de pesca durante el invierno y facilitará que la industria del gas y del petróleo funcione durante el invierno.

INICIATIVAS AMBIENTALES INTERNACIONALES Y NACIONALES

Instituto de Prevención y Control Integrado de la Contaminación: IPPC, 2005
http://www.mma.es/portal/secciones/calidad_contaminacion/ipcc/

El comité del clima de la ONU concluye en su tercer informe que para limitar el aumento de la temperatura de la Tierra en 2 ºC, las emisiones globales deben reducirse entre un 50 y un 80 por cien durante los próximos 50 años.

El protocolo de Kyoto es el primer paso de un largo camino:

La cooperación internacional está teniendo lugar en el marco de la Convención del clima de la ONU. La convención del clima incluye el Protocolo de Kyoto que trata de las obligaciones de los países industrializados para reducir sus emisiones. Se espera que el protocolo dé lugar a que el total de emisiones de los gases de efecto invernadero más importantes en los países industrializados se reduzcan un 5 por ciento por debajo de los niveles de 1990 durante el período que va de 2008 a 2012.

El protocolo de Kyoto entró en vigor el 16 Febrero de 2005. El 18 de enero de 2006, 158 países habían ratificado el protocolo. Entre estos países se incluye a Rusia, que es responsable del 17 por ciento de las emisiones. E.E.U.U, que es responsable del 36 por ciento del total de emisiones de los países industrializados, y Australia han decidido permanecer al margen. Estos países producen las descargas de gases de efecto invernadero por habitante más altas del mundo.

El Protocolo de Kyoto representa un paso importante en la política internacional sobre el clima, pero no es lo suficientemente ambicioso en lo referente a los desafíos sobre el clima a los que mundo se enfrenta. El tercer informe del Comité del Clima de la ONU deja incluso más claro que son necesarias reducciones mucho mayores de las emisiones para poder prevenir que el clima cambie de manera indeseable.

Las medidas que se están tomando con respecto al cambio climático reflejan el hecho de que éste es un tema complejo que afecta a muchos sectores de la sociedad. Hay un gran énfasis en las medidas de tipo técnico, tanto a nivel nacional como internacional. Aquí radica precisamente la posibilidad más realista de conseguir algo a corto o medio plazo. Una solución al cambio climático como problema medioambiental probablemente requerirá de iniciativas más radicales que afecten a la forma en que amplios sectores de la sociedad están organizados.

NUEVA TECNOLOGÍA QUE REDUCE LAS EMISIONES DE LOS GASES DE EFECTO INVERNADERO

Statoil, 2005
http://www.statoil.com/statoilcom/SVG00990.NSF?OpenDatabase&artid=3696C6D5014536F2412569B60029D864
6 de Junio de 2005

Muchos expertos creen que el aumento del gas de efecto invernadero dióxido de carbono (CO_2) debido al uso de petróleo y de gas está contribuyendo significativamente al calentamiento global. En los años 90, Statoil, la empresa noruega más importante en explotación, producción, transporte y venta de productos petrolíferos, por primera vez en el mundo, comenzó a almacenar este gas de efecto invernadero bajo el fondo del mar en los yacimientos de Sleipner en el Mar del Norte. Cada día, 2.800 toneladas de dióxido de carbono son separadas del gas natural producido por Sleipner. El dióxido de carbono es bombeado bajo tierra y almacenado en la formación de roca arenisca de Utsira en lugar de ser liberado a la atmósfera. Antes de que el gas sea bombeado bajo tierra se somete a una presión tan alta que se transforma en líquido. Esto facilita que el dióxido de carbono sea bombeado, y que, además, ocupe mucho menos espacio. El dióxido de carbono puede expandirse y almacenarse en áreas muy grandes. Realmente, la plataforma noruega tiene suficiente espacio para almacenar el total de emisiones de las centrales eléctricas europeas durante los próximos 800 años.

Tiempo de almacenamiento

Una pregunta que se hacen los investigadores y otras partes interesadas es "¿durante cuánto tiempo podrá mantenerse el dióxido de carbono en la formación de Utsira?". Los investigadores no pueden prometer que será un espacio de almacenamiento eterno: Pero "si el dióxido de carbono se mantiene allí hasta la próxima glaciación, dentro de 5.000 o 10.000 años a contar desde hoy, ya es suficiente," dice el encargado de proyecto Tore A. Torp. Él cree que es muy probable que no haya ningún escape en la formación durante al menos "unos pocos cientos de años". Para entonces, la edad del carbón se habrá acabado. La humanidad habrá descubierto soluciones para energías más limpias. Además, todo indica que los escapes de la formación de Utsira no serán mayores que los depósitos del dióxido de carbono que se producen de forma natural en otros lugares.

Extracción creciente

Técnicamente hablando, es posible combinar este método de almacenamiento con la creciente extracción en varios de los yacimientos de petróleo de la plataforma continental noruega. Las compañías petrolíferas lograrán así dos cosas: pueden deshacerse por sí mismas del gas de efecto invernadero mientras que al mismo tiempo utilizan el gas de efecto invernadero para extraer aún más petróleo.

APPENDIX E

SENTENCE VERIFICATION TASK (SVT)

*Algunas de las siguientes frases tienen el mismo significado que una frase de uno de los siete textos sobre el cambio climático. Algunas frases tienen un significado que no aparecía en los textos. Si crees que una frase tiene el mismo significado que una frase de uno de los textos sobre el cambio climático, marca **Sí**. Marca **No** si crees que la frase tiene un significado diferente que una de las frases de los textos.*

		Sí	***No***
1.	Según el Comité del Clima de la ONU, un aumento del efecto invernadero dio lugar a que los niveles de agua se elevaran entre 10 y 20 centímetros durante el siglo pasado y para 2100, los niveles del océano se elevarán entre 9 y 88 centímetros	□	□
2.	Temperaturas más altas podrían llevar a mejorar las condiciones de vida de las plantas y a reducir los costes de la calefacción	□	□
3.	La actividad humana ha introducido en la atmósfera, además, pequeñas cantidades de varios gases de efecto invernadero que no existen allí de forma natural	□	□
4.	El sol es una esfera enorme de gas sin ninguna superficie sólida claramente delimitada	□	□
5.	El clima de la tierra ha ido variando a lo largo del tiempo	□	□
6.	El Protocolo de Kyoto es un paso significativo en la política multilateral sobre el clima, pero no es lo suficientemente progresista con respecto a los problemas del clima a los que el mundo se enfrenta	□	□
7.	El aumento de la concentración del CO_2 en la atmósfera constituye el primer componenete (alrededor del 60%) de la intensificación del efecto invernadero del cual la naturaleza es responsable.	□	□
8.	El Ártico se desplazará en dirección Norte y en dirección Este debido a las actividades humanas	□	□
9.	El problema es que el ecosistema es muy complejo y sensible, y cambios muy pequeños pueden tener grandes consecuencias	□	□
10.	Se ha debatido mucho acerca del clima durante los últimos años y la discusión raramente ha girado en torno al grado en que las actividades humanas están influenciando nuestro clima en comparación con los cambios naturales	□	□

		Sí	***No***
11.	Recientemente, los investigadores del clima han decubierto que la temperatura media de la tierra se elevó aproximadamente 5°C entre 1950 y 2004	☐	☐
12.	Las Regiones Nórdicas serían considerablemente más frías sin la Corriente del Golfo	☐	☐
13.	El calentamiento global también puede intensificar la Corriente del Golfo y provocar un enfriamiento grave en el norte de Europa	☐	☐
14.	Muchos oceanógrafos temen po toda la basura que se generará por el aumento del tráfico naval en las regiones nórdicas	☐	☐
15.	La luz visible y de longitud de onda larga representa la mayor parte de la energía de la radiación del sol	☐	☐
16.	Que el hielo que rodea los polos se esté derritiendo implica un aumento en el acceso a agua dulce limpia	☐	☐
17.	Al final del siglo pasado, Statoil, por primera vez en el mundo, comenzó a depositar el dióxido de carbono en los yacimientos de Sleipner en el Mar del Norte	☐	☐
18.	En conjunto, todo indica que los escapes de la formación de Utsira serán mayores que los depósitos de dióxido de carbono que se producen de forma natural en otros lugares	☐	☐
19.	Si la circulación del Océano Atlántico cambia, podríamos tener una disminución de la temperatura media de 3-5 ºC	☐	☐
20.	La cooperación internacional está teniendo lugar en el marco de la Convención del clima de la ONU	☐	☐
21.	En los últimos años, las actividades humanas también han llevado al aumento de los depósitos de petróleo y de gas en las Regiones Nórdicas	☐	☐
22.	Las emisiones de CO_2 de origen humano se deben en primer lugar y sobre todo al consumo de combustibles fósiles (carbón, petróleo y gas) y a la tala de árboles de las regiones tropicales	☐	☐
23.	El efecto invernadero es ante todo un proceso de origen humano y necesario	☐	☐
24.	Ahora parece que por primera vez, los seres humanos se enfrentan a un cambio climático mundial debido a sus propias actividades	☐	☐
25.	Las regiones del Artico a las que hemos conseguido acceder esconden además enormes recursos	☐	☐

		Sí	***No***
26.	El Comité del clima de la ONU resume en su tercer informe que para limitar la subida mundial de la temperatura a 2 ºC, el total de emisiones deben reducirse entre un 50-80 por ciento durante la primera mitad de este siglo	□	□
27.	Según expertos de la ONU, las temperaturas alrededor del Polo Norte están aumentando a un ritmo doble que en otros lugares del mundo	□	□
28.	Hasta ahora el protocolo de Kyoto ha tenido gran importancia en alteraciones del clima, tales como el aumento en los niveles de agua – especialmente en países en vías de desarrollo	□	□
29.	El total de emisiones de los seres humanos suponen simplemente una pequeña parte de la cantidad de gases de efecto invernadero liberadas a las capas de aire que rodean la tierra y desempeñan un papel menor en comparación con, por ejemplo, la contribución del vapor de agua natural	□	□
30.	La platafoma noruega tiene, de hecho, suficiente espacio para almacenar las emisones totales de las centrales eléctricas europeas durante los próximos 800 años	□	□
31.	Los cambios que se han producido entre las edades de hielo y períodos más cálidos no están relacionados con condicionantes astronómicos externos	□	□
32.	La mitad de los rayos solares que impactan en la atmósfera de la tierra penetran hasta la superficie de la tierra, el resto son reflejados por las nubes y otros gases.	□	□
33.	Los cambios en el clima de la tierra están provocados en gran medida por condicionantes astronómicos	□	□
34.	En el informe también se habla de la convención sobre el clima, que se centra especialmente en las regiones oceánicas.	□	□
35.	Sin el sol no tendríamos efecto invernadero, el cual es un prerrequisito para que nuestro planeta tenga condiciones habitables.	□	□
36.	El hielo del Ártico se está derritiendo tan rápidamente que para el invierno de 2050 podría haber un pasillo marítimo accesible para barcos normales entre el Océano Atlántico y el Océano Pacífico	□	□
37.	La Convención sobre el clima incluye el Protocolo de Kyoto que trata de las obligaciones de los países en vías de desarrollo para reducir sus emisiones	□	□

		Sí	***No***
38.	Solamente grandes variaciones en la radiación del sol afectarán al clima	□	□
39.	Las emisiones naturales de los gases de efecto invernadero forman parte de un ciclo en el cual, por ejemplo, los árboles vivos desprenden CO_2 y los árboles en descomposición absorben CO_2 a través de la fotosíntesis	□	□
40.	Desde la revolución industrial la concentración del dióxido sulfúrico ha aumentado un 150 por cien, la presencia de carbón ha aumentado un 31 por cien, y el uso del gas ozono ha aumentado un 17 por cien	□	□

APPENDIX F

INTRATEXTUAL INFERENCE VERIFICATION TASK (IntraVT)

Cada una de las siguientes frases son afirmaciones que pueden deducirse razonablemente de uno de los textos que acabas de leer, o bien son afirmaciones que no pueden deducirse razonablemente de ninguno de los siete textos. Si la frase puede deducirse razonablemente a partir de la información de uno de los siete textos, marca ***Sí.*** *Si la frase no puede deducirse razonablemente a partir de la información de uno de los siete textos, marca* ***No.***

		Sí	***No***
1.	Un clima más cálido en el Ártico puede llevar a que algunas actividades comerciales tradicionales sean substituidas por nuevas actividades industriales.	□	□
2.	El aumento en la evaporación de los océanos puede llevar a que se produzcan más desastres naturales en el futuro.	□	□
3.	El calentamiento global puede deberse al hecho de que los campos magnéticos del sol atraen a la tierra y a otros planetas hacia el sol	□	□
4.	El calentamiento global puede provocar tanto un enfriamiento en el norte de Europa como un aumento en la temperatura media de la tierra	□	□
5.	El Protocolo de Kyoto no obliga a los países miembros a llevar a cabo suficientes reducciones en sus emisiones durante los próximos 50 años	□	□
6.	El almacenamiento de dióxido de carbono bajo el fondo del mar es probablemente una forma muy insegura de almacenamiento	□	□
7.	El comité del Clima de la ONU concluye que las emisiones de gases de efecto invernadero de origen humano han provocado un efecto invernadero más intenso en las últimas décadas	□	□
8.	El cambio climático de la Tierra está provocado en gran medida por condicionantes astronómicos, aunque éstos sólo pueden llevar a cambios de temperatura al nivel de tantos por mil	□	□
9.	El derretimiento del hielo en las regiones nórdicas puede llevar a conflictos territoriales entre países como Canadá y EEUU	□	□
10.	Las emisiones de CO_2 debidas a la combustión de combustibles fósiles y a la tala de árboles en las regiones tropicales forman parten de un ciclo en el cual, por ejemplo, los árboles en descomposición desprenden CO_2 y los árboles vivos absorben CO_2 a través de la fotosíntesis	□	□

		Sí	***No***
11.	EEUU y Australia no han ratificado el Protocolo de Kyoto porque creen que se necesitan reducciones mucho mayores para poder prevenir que el clima evolucione de manera indeseable.	□	□
12.	Sin el efecto invernadero de origen humano la temperatura media de la Tierra sería muchos grados más fría de lo que es ahora.		
13.	El bombeo bajo tierra de CO2 en los depósitos subterráneos de petróleo puede ser económicamente provechoso para las compañías petrolíferas	□	□
14.	Una solución a largo plazo para los problemas del clima podría requerir un gran cambio político	□	□
15.	El efecto invernadero natural es mucho más importante para la temperatura media de la Tierra que el efecto invernadero de origen humano.	□	□
16.	Los estudios sobre los cuerpos celestes pueden proporcionarnos conocimientos sobre las causas del cambio climático.	□	□
17.	Un debilitamiento de la Corriente del Golfo puede crear mejores condiciones para la agricultura y los bosques de la región Nórdica.	□	□
18.	La temperatura media de la tierra aumenta porque un incremento en la cantidad de gases de efecto invernadero en la atmósfera impide que los flujos de calor de longitud de onda de onda larga salgan de la Tierra	□	□
19.	Sin las emisiones de CO_2 de origen humano en la atmósfera, el calentamiento de la superficie de la Tierra y de la capa de aire de alrededor de la Tierra no podrían ser comparados con lo que ocurre en un invernadero	□	□
20.	La combustión de combustibles fósiles y la tala de árboles en las regiones tropicales son los principales responsables de la intensificación del efecto invernadero.	□	□
21.	Los acuerdos internacionales gestionados por la ONU pueden contribuir a la reducción del total de emisiones de gases de efecto invernadero de los países industrializados en un futuro próximo	□	□

		Sí	***No***
22.	Probablemente, el dióxido de carbono en estado líquido puede ser almacenado de forma segura en las formaciones de roca arenisca durante cientos de años	□	□
23.	El incremento de las temperaturas alrededor del Polo Norte puede llevar a un aumento en la extracción de petróleo y de gas	□	□
24.	Las emisiones de CO_2 de origen humano contribuyen poco a la intensificación del efecto invernadero en comparación con el impacto natural del vapor de agua	□	□
25.	El cambio climático global puede estar provocado por el espacio al menos tanto como por la tierra	□	□
26.	El almacenamiento bajo el fondo del mar puede contribuir a reducir las emisiones de CO_2 procedentes de la producción de gas de las compañías petrolíferas	□	□
27.	Debido a alteraciones en la circulación de corrientes en el Atlántico, podríamos tener una subida catastrófica de los niveles del agua hacia 2100 -especialmente en países en vías de desarrollo	□	□
28.	El gas natural extraído por las compañías petrolíferas contiene una cantidad considerable de dióxido de carbono (CO_2)	□	□
29.	Para satisfacer las exigencias del Protocolo de Kyoto sobre las reducciones de emisiones, es necesario implementar iniciativas radicales que afecten a la forma en que amplios sectores de la sociedad están organizados.	□	□
30.	Un debilitamiento de la Corriente de Golfo podría afectar negativamente a la agricultura y a los bosques en las regiones nórdicas.	□	□
31.	Un clima más cálido en el Ártico podría reducir la necesidad de calefacción hasta tal punto que no habrá necesidad de utilizar los enormes depósitos de petróleo y de gas que están siendo accesibles allí	□	□
32.	El aumento del efecto invernadero puede llevar a pérdidas significativas de territorio a países como Holanda, Bangladesh, y Las Maldivas	□	□

		Sí	***No***
33.	Uno de los principales problemas para la cooperación internacional es que algunos de los países que producen las descargas más altas no han firmado el Protocolo de Kyoto	□	□
34.	En las regiones nórdicas, enormes riquezas pueden llegar a ser accesibles debido a la reducción de la distancia del viaje a Asia a través del Pasillo del Noroeste	□	□
35.	Bombear dióxido de carbono bajo tierra no puede ocasionar reducciones realmente importantes de las emisiones porque la capacidad de almacenamiento de la plataforma Noruega es demasiado pequeña.	□	□

APPENDIX G

INTERTEXTUAL INFERENCE VERIFICATION TASK (IntERVT)

Cada una de las siguientes frases son afirmaciones que pueden deducirse razonablemente combinando información de al menos dos de los textos que acabas de leer, o bien son afirmaciones que no pueden deducirse razonablemente de dos o más de los siete textos. Si la frase puede ***deducirse razonablemente*** *a partir de la información de dos o más de los siete textos, marca* ***Sí.*** *Si la frase* ***no puede deducirse razonablemente*** *a partir de la información de dos o más de los siete textos, marca* ***No.***

		Sí	***No***
1.	Para limitar el efecto invernadero natural, el Comité del clima de la ONU recomienda que los países industrializados reduzcan considerablemente el consumo de combustibles fósiles durante los próximos 50 años	☐	☐
2.	El incremento en el consumo de combustibles fósiles por parte de los seres humanos puede aumentar los depósitos de oro, diamantes, cobre, y cinc en las regiones nórdicas.	☐	☐
3.	El énfasis unilateral en las consecuencias positivas del calentamiento global puede disminuir el interés por cumplir el protocolo de Kyoto	☐	☐
4.	Los acuerdos internacionales actuales sobre iniciativas medioambientales representan un paso en la dirección correcta, pero están lejos de prevenir suficientemente los graves desastres naturales que amenazan a muchas comunidades costeras	☐	☐
5.	Las nuevas tecnologías pueden hacer posible el almacenamiento de las emisiones naturales de los gases de efecto invernadero	☐	☐
6.	El amplio consumo de combustibles fósiles, que ha dado lugar a un efecto invernadero más intenso, también puede proporcionar a los seres humanos acceso a nuevas áreas para la extracción de petróleo y de gas	☐	☐
7.	Incluso el aparentemente insignificante aumento de la temperatura media de la tierra durante los últimos 150 años puede tener importantes consecuencias para la vida en la tierra	☐	☐
8.	El calentamiento global que tiene lugar actualmente puede deberse a una intensificación del efecto invernadero de origen humano y a condicionantes astronómicos	☐	☐
9.	Eliminando el dióxido de carbono del gas natural puede conseguirse un tráfico marítimo entre el Océano Atlántico y el Océano Pacífico mucho más favorable en términos medioambientales cuando la ruta a través del Paso del Noroeste esté abierta	☐	☐

		Sí	***No***
10.	La resistencia a firmar los acuerdos ambientales internacionales puede deberse a las discrepancias sobre las causas del calentamiento globaL	□	□
11.	Las posibilidades de extracción de grandes recursos naturales en las regiones nórdicas puede aumentar la probabilidad de que los países industrializados se unan para cumplir las estrictas recomendaciones del comité del clima de la ONU	□	□
12.	Una completa utilización de la capacidad de almacenamiento de la Plataforma continental noruega puede contribuir al logro de los objetivos del Protocolo de Kyoto	□	□
13.	La intensificación del efecto invernadero ha hecho que las compañías petrolíferas desarrollen nuevas tecnologías para separar e inyectar el dióxido de carbono	□	□
14.	Con la tecnología actual podemos almacenar todas las emisiones de gases de efecto invernadero bajo el fondo del mar	□	□
15.	El calentamiento global podría tener un impacto negativo en la economía de muchos países, mientras que en otras partes del mundo podría crear nuevas oportunidades económicas	□	□
16.	El cambio climático por causas naturales puede abrir el Paso del Noroeste como ruta de transporte	□	□
17.	Cuando se eleven los niveles de agua porque el hielo que rodea los polos se esté derritiendo, el acceso a los enormes recursos de las regiones nórdicas podría llegar a ser más difícil	□	□
18.	Las actividades humanas en áreas de bosque tropical pueden contribuir a que haya un clima más frío en las Regiones Nórdicas	□	□
19.	Algunas explicaciones causales del calentamiento global quitan importancia a la implementación de iniciativas para reducir las emisiones de gases de efecto invernadero.	□	□
20.	El riesgo de enfriamiento grave y duradero de Norteamérica ha ocasionado que los EEUU opten por permanecer al margen de importantes acuerdos que tienen como objetivo limitar el calentamiento global	□	□
21.	El cambio climático debido a condiciones naturales puede no ser importante para las posibilidades de extraer petróleo y gas de los depósitos del Ártico	□	□
22.	Lo que sucede en el espacio puede dar lugar a un grave enfriamiento en el norte de Europa	□	□

		Sí	***No***
23.	Almacenando dióxido de carbono bajo el fondo del mar, probablemente no tendremos que realizar más cambios sociales radicales para encontrar una solución al cambio climático como problema ambiental	□	□
24.	El aumento en la concentración de dióxido de carbono en la atmósfera puede llevar a que la Corriente de Golfo sea significativamente más fría	□	□
25.	Diferentes tipos de condicionantes astronómicos tienen gran importancia para una intensificación del efecto invernadero	□	□
26.	La posibilidad de almacenar gas de efecto invernadero bajo tierra puede aumentar las oportunidades de una extracción más favorable en términos medioambientales de los grandes depósitos de gas en el Ártico	□	□
27.	El total de emisiones de dióxido de carbono de origen humano solamente representa una pequeña parte de la cantidad de gases de efecto invernadero liberadas a la atmósfera, y estas emisiones, por lo tanto, no se incluyen en la cooperación internacional en el marco de la Convención del clima de la ONU	□	□
28.	Almacenando dióxido de carbono bajo tierra, nos arriesgamos a sufrir dramáticas consecuencias para la agricultura y los bosques	□	□
29.	El efecto invernadero natural puede provocar que los niveles de agua se eleven casi un metro durante los próximos 100 años	□	□
30.	Las consecuencias negativas de la intensificación del efecto invernadero están llegando a ser tan amplias que las compañías petrolíferas han tenido que desarrollar una tecnología más favorable en términos medioambientales.	□	□

APPENDIX H

ORAL INSTRUCTIONS

Queremos pediros vuestra colaboración para un proyecto sobre lectura de textos expositivos. El proyecto es fruto de la cooperación entre investigadores de la Universidad de Oslo, e investigadores de la universidad de Valencia. La colaboración que os pedimos tiene dos partes, y se llevará a cabo en dos días diferentes. El primer día podréis participar todos. El segundo solo participareis una parte de la clase seleccionada a partir de las contestaciones a los cuestionarios que contestareis hoy. Esto lo hacemos así porque el proyecto requiere estudiantes con una serie de conocimientos específicos. No obstante, los que no participen ahora, podrán hacerlo más adelante en otras investigaciones sobre comprensión y aprendizaje de textos que estamos planificando. Primeramente os explicaremos las tareas y después decidiréis si queréis participar voluntariamente en la investigación.

En la sesión de hoy se trata de contestar a varios cuestionarios, la mayoría de los cuales tratan sobre temas relacionados con la naturaleza y el medio ambiente, ya que los textos que se leerán en la segunda sesión tratan sobre estos temas. No hay límite de tiempo para contestar a los cuestionarios, pero el tiempo aproximado que emplearéis es 30 minutos. La segunda sesión consistirá en leer unos textos sobre temas relacionados con la naturaleza y el medio ambiente y contestar unas preguntas sobre lo leído. La tarea de lectura y parte de las preguntas se harán en un ordenador con un procedimiento especial que explicaremos en su momento. Ello nos permitirá registrar el proceso de comprensión y aprendizaje del contenido de los textos, ya que el objetivo último de la investigación es conocer en detalle este proceso. El tiempo aproximado de esta segunda sesión es una hora. Esta segunda sesión se realizará en grupos de 10 estudiantes ya que ese es el número de ordenadores que tenemos disponibles. Avisaremos de la composición de cada grupo y de la hora de realización en la próxima clase de esta asignatura. En todo caso, aprovecharemos las horas de clase de esta semana en que el profesor no se habrá incorporado a fin de que no tengáis que dedicar un tiempo extra fuera de clase a la colaboración. En todo caso, proporcionaremos un informe de los resultados obtenidos en las diferentes pruebas a cada uno de vosotros que nos lo pida.

¿Tenéis alguna pregunta antes de pasar a explicar con más detalle lo que vamos a hacer hoy? … Os agradeceríamos que participarais, pero si alguno no desea hacerlo puede salir del aula.

Brevemente os explicaremos la tarea de hoy. A continuación repartiremos un cuadernillo con varios cuestionarios. Cada cuestionario comenzará con instrucciones acerca de cómo contestarlo. Es muy importante que leáis las instrucciones atentamente. También es importante que completéis las tareas en el mismo orden en el que te han sido repartidas. No debeis mirar los materiales antes de que os digamos que lo hagáis.Ninguna tarea tiene límite de tiempo.

Si tenéis cualquier pregunta mientras estéis contestando los cuestionarios, podéis consultarnos. Cuando acabéis, podéis entregar el cuadernillo.

APPENDIX I

TASK INSTRUCTION: ARGUMENT ESSAY

Vas a leer en el ordenador una serie de textos sobre temas relacionados con el clima. Después tendrás que escribir un informe breve dirigido a otros estudiantes donde *expreses y justifiques tu opinión personal sobre cómo el cambio climático puede influenciar la vida en la Tierra y cuáles son las causas del cambio climático.* Fundamenta tu informe en la información incluida en los 7 textos. Utiliza la información más relevante, e intenta expresarte con claridad y elaborar la información preferiblemente con tus propias palabras.

Procede de la siguiente forma:

1.- Lee los textos en el orden que consideres oportuno.

2.- Tienes 35 minutos para leer los textos.

3.- Tienes 15 minutos para elaborar el informe. Mientras estés elaborando el informe no podrás consultar los textos.

4. Cuando termines de leer, o bien pase el tiempo fijado, selecciona el botón Tarea para escribir el informe.

APPENDIX J

TASK INSTRUCTION: SUMMARY

Vas a leer en el ordenador una serie de textos sobre temas relacionados con el clima. Después tendrás que escribir un informe breve dirigido a otros estudiantes que *resuma cómo el cambio climático puede influenciar la vida en la Tierra y cuáles son las causas del cambio climático.* Fundamenta tu informe en la información incluida en los 7 textos. Utiliza la información más relevante, e intenta expresarte con claridad y elaborar la información -preferiblemente con tus propias palabras.

Procede de la siguiente forma:

1.- Lee los textos en el orden que consideres oportuno.

2.- Tienes 35 minutos para leer los textos.

3.- Tienes 15 minutos para elaborar el informe. Mientras estés elaborando el informe no podrás consultar los textos.

4. Cuando termines de leer, o bien pase el tiempo fijado, selecciona el botón Tarea para escribir el informe.