We consider how the development of students’ capabilities for identifying business opportunities is underpinned by a change in their opportunity-identification mental frames. We observe that students find it difficult to verbally articulate how their performance has changed, and yet such changes are reflected through radical shifts in their visual representations of entrepreneurship. We conclude that entrepreneurship courses need to change the way students perceive reality and interpret information to enable them to more effectively identify new business opportunities.

Although there is much debate surrounding the definition and meaning of entrepreneurship, many scholars associate this concept to a greater or lesser extent with the identification of opportunities (Alberti, Sciascia, & Poli, 2005; Ardichvili, Cardozo, & Ray, 2003; Eckhardt & Shane, 2003; Kirzner, 1997; Ma & Tan, 2006; Shane & Venkataraman, 2000; Stevenson & Gumpert, 1985). Opportunity identification (OI) is the starting point from which all entrepreneurs begin (Carrier, 2005:141); “the key to the engine that starts new businesses” (Corbett, 2007: 98); and also “the quest for growth through innovation” by existing companies (Stevenson & Jarillo, 1990: 25). For some, it is even the core of entrepreneurship (Gaglio, 1997; Gaglio & Katz, 2001; Krueger, 2000; Rae, 2003; Stevenson & Gumpert, 1985; Timmons, Muzyka, Stevenson, & Bygrave, 1987).

Entrepreneurs, in turn, are seen as economic agents who may develop a special capability to identify opportunities (Fiet, 2002: 3). This opportunity-identification capability (OIC) is considered fundamental for successful entrepreneurial performance (Ardichvili et al. 2003; Carrier, 2005, 2007; Chandler & Jansen, 1992; Politis, 2005). It has been reported that successful entrepreneurs rate themselves highly when referring to their opportunity-identification capability (Chandler & Jansen, 1992) and that habitual entrepreneurs identify more opportunities than do novice entrepreneurs (Ucbasaran, Westhead, Wright, & Binks, 2003; Ucbasaran, Westhead, & Wright, 2006).

In the educational context, some empirical evidence suggests that OIC can be developed by individuals and that entrepreneurship education can play an important role in enhancing its development (DeTienne & Chandler, 2004; Fiet, 2002). However, there is little consensus on this issue (Carrier, 2007). For example, Sacks and Gaglio (2002) reported that educators tend to consider it feasible to teach students how to assess business ideas, but much less feasible to teach students how to discover and create opportunities in the first place.

The extent to which opportunity-identification capability (OIC) development can be enhanced by teaching has profound implications for entrepreneurship education and economic performance. On the one hand, if OIC development cannot be enhanced by teaching, then the role of entrepreneurship education is reduced to an informative or descriptive one. As Fiet, Clouse, and Norton pointed out: “The only role that educators could
play (in such a context) would be to administer screening instruments to advise students about their prospects of success” (2004: 3, parenthesis added). On the other hand, if OIC development can be enhanced by teaching, then the role and importance of entrepreneurship education are expected to be significant not only for aspiring entrepreneurs, but also for future executives, and potentially for anyone wishing to become more entrepreneurial.

If we assume that OIC development can be enhanced by teaching, then there must be key factors idiosyncratic to the individual that change during the learning process and make individuals more capable of identifying opportunities. Along these lines, several authors have proposed that entrepreneurs’ ability to identify opportunities can be associated with particular mental frames (e.g., Baron 2004b; Gagliò & Kantz, 2001; Krueger, 2000); therefore, these OI mental frames, developed over time, may explain why entrepreneurs are capable of perceiving reality differently than others, and therefore, of making new connections between external stimuli when identifying opportunities.

We report empirical evidence supporting the idea that OIC are underpinned by particular OI mental frames and that those mental frames can be enhanced by education. Therefore, for OI education to be effective, a development of students’ mental frames is necessary. We conducted a qualitative study in which 15 students of very different backgrounds were analyzed while taking part in an entrepreneurship course delivered in the context of an award-winning entrepreneurship program. This program is unusual, as it applies an integrative learning approach where theory, practice, and reflective learning are combined within the delivery and assessment schema (Binks, Starkey, & Mahon, 2006; Huber & Hutchins, 2004). Our research investigated whether there was any development of OIC by the students and investigated evidence of any corresponding changes in their OI mental frames.

We assessed students’ OIC development using a methodology adapted from DeTienne and Chandler (2004). Then, we assessed students’ changes in OI mental frames by using visual representations. Last, we compared our visual data with students’ verbal testimony. The use of visual representation allowed us to capture changes in mental frames that are tacit (e.g., Fiet, 2002: 3; Johnson-Laird, 1983: xi) or not directly accessed through techniques that rely on the spoken or written word. The remainder of the article is structured as follows: After reviewing the literature related to OIC development with a special emphasis on its relation to OI mental frames and entrepreneurship education, we present the main proposition directing our research. Following this, we present the research design developed to assess our proposition. Then we present our results and discuss the implications and contributions. Last, we present our main conclusions.

THE DEVELOPMENT OF OIC

For the identification of opportunities, in addition to specific knowledge about a potential technology or market, people need a particular cognitive capacity that enables them to make novel connections and foresee potential opportunities (Buenstorf, 2007; Corbett, 2005; Politis, 2005; Shane & Venkataraman, 2000; Venkataraman, 1997). Capabilities in general can be defined as “what people are actually able to be and do” (Walker, 2005: 103). Along these lines, it can be said that OIC integrates the ability to process external stimuli in a particular way, as well as the ability to create a business solution from those external stimuli. As Shane and Venkataraman (2000: 222) pointed out: “People must be able to identify new means–ends relationships that are generated by a given change to discover entrepreneurial opportunities. Even if a person possesses the prior information necessary to discover an opportunity, he or she may fail to do so because of an inability to see new means–ends relationships.”

Several authors argue that entrepreneurs differ from other economic agents in their higher capability to identify opportunities (Alvarez & Busenitz, 2001; Ardichvili et al., 2003; Corbett, 2005; Fiet, 2002; Shane 2003). Also argued is that this capability, called entrepreneurial competence (Fiet, 2002), is considered fundamental for successful entrepreneurial performance (Ardichvili et al. 2003; Carrier, 2005; Chandler & Jansen, 1992). Thus, entrepreneurs’ ability to “frame situations in an opportunistic manner is a heterogeneous resource that can be used to organize other resources” (Alvarez & Busenitz, 2001: 759).

Building upon this work, we argue that opportunity-identification capability (OIC) is a critical antecedent of the OI process and thus research into this topic is potentially important for both theory and practice. Whereas most approaches to opportunity identification analyze specific events (e.g., how a specific opportunity was identified), the OIC approach focuses on a condition that underpins several decisions over time. On the one hand, specific knowledge needed for the identification and development of opportunities (e.g., knowledge about underserved markets or of how to produce a particular product) is idiosyncratic to the
identification of one particular opportunity. On the other, OIC has generic relevance and is not business or industry specific (Lumpkin, Hills, & Shrader, 2004).

The idea that entrepreneurs possess a specific ability that makes them capable of identifying opportunities implies that other aspects of the entrepreneurs’ background, such as prior entrepreneurial exposure and education, could contribute to the development of this capability. Therefore, this capability may represent both a measure of the entrepreneurs’ ability to identify opportunities and other influences upon on the development of this capability. Last, since this capability develops over time, it could be enhanced by teaching, giving support to the idea that entrepreneurship education can be an effective way to enhance the development of such a capability.

Entrepreneurs’ abilities to identify opportunities are largely tacit in nature. Sternberg (2004) pointed out that to be successful, entrepreneurs need practical abilities (i.e., abilities to solve everyday life problems), that are based mainly on tacit knowledge. Fiet (2002) argued more specifically that entrepreneurial competence consists mainly of tacit knowledge. Kor, Mahoney, and Michael (2007: 1195) similarly pointed out that “discovering markets and accurately evaluating products markets and technologies involve the development of tacit knowledge” and that this can be “an important source of sustainable competitive advantage” for companies.

However, while much attention has been devoted to the influence that this capability exerts during the OI process, little effort has been paid to its development. Were it a natural gift that only some particular people—entrepreneurs—possess, then little can be done to enhance its development. If it can be “developed” (and there is evidence to support the idea that entrepreneurship education can be an effective way to enhance the development of such a capability).

The Development of OIC and OI Mental Frames

Several authors have proposed that entrepreneurs’ ability to identify opportunities is underpinned by particular mental frames related to OI (e.g., Baron 2004b; Gaglio & Katz, 2001; Krueger, 2000). Some people are more capable of identifying opportunities than others because they perceive reality differently (Baron, 1998, 2000; De Carolis & Saparito, 2006). As Gaglio and Katz (2001: 97) pointed out: “(C)ompared to other market actors, entrepreneurs have a better grip on reality because they perceive it more accurately and are better at inferring the likely implications and consequences.” This then focuses attention upon the nature of the relationship between mental frames and OI (Baron 2004a). The traditional way of characterizing mental frames is through the cognitive concept of a mental model. This idea is based on the original work of Kenneth Craik (1943), who proposed that human beings are processors of information. The concept of mental models has been broadly disseminated by the psychologist Philip Johnson-Laird. He argues that humans construct mental models of the world “by employing tacit mental process” (Johnson-Laird, 1983: x). Cognitive psychology basically focuses upon the structure of those models and the way they are used (Johnson-Laird, 1983: xi). Our research focuses on how these models or mental frames are formed and modified by learning. However, this is complicated, as these adaptations appear to occur in a tacit way. As a consequence, individuals cannot give a complete account of the process or fully recognize the causes of change in mental frames and how these have been produced.

The important role that OI mental frames play during the OI process has been recognized within the OI literature. These mental frames have been characterized with names such as pattern recognition (Baron, 2004b; schema Baron, 2004b; Gaglio & Katz, 2001; Krueger, 2000); entrepreneurial mind-set (Gr McGrath & MacMillan, 2000); and mental models (Cope, 2003). Concepts such as cognitive biases similarly underlie the fact that certain aspects of entrepreneurs’ cognition make them act differently from other people (Baron, 1998 2000; Busenitz & Barney, 1997; De Carolis & Saparito, 2006). However, we argue that although several authors have highlighted the importance of the OI mental frames, the particular link between OIC development and OI mental frames is still unclear.
Our research represents an effort to empirically explore this link in the context of entrepreneurship education.

The Development of OIC and Entrepreneurship Education

Opportunity identification is a core element of entrepreneurship. Accordingly, it has been argued that the entrepreneurial learning process should be an opportunity-centered process (Rae, 2003), and that one of the main outcomes of entrepreneurship education should be the success of enhancing this capability (Kourilsky, 1995; Ray 1990). It also has been argued that the emphasis of OI in entrepreneurship education differentiates this type of education from general business education (Solomon, Duffy, & Tarabishy, 2002). Some scholars have even defined entrepreneurship education as “the process of providing individuals with the concepts and skills to recognize opportunities that others have overlooked” and to act upon them (Fisher, Graham, & Compeau, 2008: 315).

In this context, teaching OIC is argued to be “a particularly important component of entrepreneurship education” (Lumpkin et al., 2004: 87). As explained earlier, whereas much of the knowledge needed to identify single opportunities is context specific, the OIC is a more general ability that allows those who possess it to act in different contexts (Lumpkin et al., 2004: 86–87). However, although some studies have provided evidence supporting the idea that this capability can be enhanced by teaching (DeTienne & Chandler, 2004; Fiet, 2002), not everyone considers this possible (Carrier, 2007; Sacks & Gaglio, 2002). Research is still lacking in how this capability develops during the students’ learning process and how educational practice affects its development.

Although some endeavors have related OI and learning (e.g., Corbett, 2005, 2007) the particular link between OIC development and OI mental frames is still unclear. Nadkarni has reported that an increase in the complexity of mental models is an appropriate measure of students’ learning (Nadkarni, 2003). Thus, facilitating learning implies enhancing the learner’s adaptation of those mental frames to allow the acquisition and use of new knowledge or capabilities. Mental frames represent the prevailing levels of understanding and capability in particular activities that are developed to first learn and then perform that activity. Therefore, changing mental frames is central to the capability-development process. It may also enable individuals to deploy their existing capability more effectively. Fiet (2002) reported that all graduate students can significantly enhance their OIC by focusing on information that they already possess. That is, regardless of how creative students seem to be, when they focus on seeing what they already know in a different way, they can effectively improve their OIC. DeTienne and Chandler (2004) similarly reported that different types of people, from the more innovative to the more adaptively inclined, increased their capacity to recognize opportunities after receiving opportunity-identification capability training. Thus it can be implied that people may become more capable of identifying opportunities by developing their OI mental frames, leading to the following proposition:

Proposition: Students who develop their OIC during an entrepreneurship course will also show significant changes in their mental frames regarding entrepreneurial activity.

RESEARCH DESIGN

We undertook a qualitative study consisting of two rounds of semistructured interviews including open-ended questions, an opportunity assessment, and pictorial representations. Fifteen students were investigated as they took part in an award-winning entrepreneurship module. “Entrepreneurship and Business” is an undergraduate module of the Nottingham University Business School. It was chosen as a research context for two reasons: First, its scale and scope (it is one of the largest entrepreneurship modules in the world with around 1,800 undergraduate students on three different campuses: 850 in the UK, 700 in China, and 250 in Malaysia); and second, due to its innovative educational approach, which is considered to be among the most effective for entrepreneurship within the UK (Botham & Mason, 2007; “The Winners,” 2008).

The module aims to encourage students to develop their entrepreneurial creativity by enhancing their OIC through an integrative learning approach. “Integrative Learning involves rich intentional learning characterised by the individual student’s ability to make deep level connections between the processes of academic learning, reflective self awareness, personal development and experiential learning in a range of practical contexts” (Binks, 2005: 2). Many educational approaches tend to encourage students to compartmentalize their learning in disciplines and subdisciplines rather than to integrate the knowledge and capabilities that they gain from the educational experience. In contrast, the development of
entrepreneurial capabilities requires an integrative approach since this development needs “a mixture of knowledge and understanding, interpersonal skills and competences and various thinking styles and behaviours in order to be successful” (Binks, 2005: 3).

Four initial formal lectures explain the main theoretical content. In this part of the module the emphasis is on the communication of explicit entrepreneurial knowledge. Students then self-select into teams of five in tracks of 100. Having agreed to focus upon a particular “issue,” “problem,” or “need,” each group then proceeds to apply convergent and divergent thinking styles using a creative problem-solving process (CPS), subsequently refined and codified as the “Ingenuity Approach” (Kirkham, Mosey, & Binks, 2009). Students are mentored throughout these three sessions by local entrepreneurs and business practitioners who have been trained in the application of CPS. After using convergent “linear” thinking to define the problem and identify its root causes, groups then focus upon a single element or cause and brainstorm multiple solutions through divergent or “lateral” thinking. Returning to a convergent thinking style, they then work toward the identification of a single optimal or best solution. Each group then presents its solution to their chosen problem through an “elevator pitch” alongside an A2-sized poster representing their idea. After each mentoring session, students are sent a link by way of e-mail to the integrative learning barometer (ILB; www.learningbarometer.com), an on-line learning tool that encourages students to provide responses to a variety of questions and requires them to reflect upon their learning during the mentoring session and afterward, and present this reflection in at least 250 words. Although question responses are published on the ILB website, the individual reflections are confidential and constitute in total 15% of the module assessment. The poster presentation and pitch constitute a further 40%, and the remaining 45% is assessed by students’ submission of an individual innovation report. This final element of the assessment requires students to consider the innovation of their chosen invention (e.g., iPod, biro, zip fastener, life insurance, etc.) and analyze its development and impact from a theoretical perspective.

**Criteria Used to Select the Students**

Fifteen students were identified for the study. They were selected to represent maximum diversity within the cohort, and thereby, enable the observation of similarities and differences relating to a wide range of potentially influential variables. The variables used to select the potential students were prior entrepreneurial exposure, entrepreneurial intention, cultural background, degree, discipline, and gender. Such a diversity of students also enhanced the external validity of the study (Yin, 2003).

All variables are argued to have a potential effect on the students’ OIC development and are commonly used as control variables in quantitative entrepreneurship education studies (e.g., DeTienne & Chandler, 2004; Krueger, 1993; Lüthje & Franke, 2003; Peterman & Kennedy, 2003; Souitaris, Zerbinati, & Al-Laham, 2007). The first variables used to classify the potential students were cultural background and degree discipline. From these variables the following four categories were defined: British business students, other European business students, Asian business students, British students of other degrees. Next, the students of each group, different degrees of entrepreneurial exposure (e.g., coming from a family business background, having run their own business, etc.), entrepreneurial intentions, and gender. The definitive profiles of the 15 students participating in the study are shown in Table 1.

**Data Collection Procedures**

The following procedures were applied to select students and gather the relevant data. First, students were invited to participate in the study during the first session of the course. Second, students who wanted to participate in the study were asked to complete a short questionnaire at the end of the session to collect the data required to select the participants. Third, once those students interested in participating in the study had filled in the questionnaires (101 students), the potential candidates were selected according to the criteria previously explained. Potential candidates were then invited to participate through e-mail. Having confirmed their intention to participate in the study, the students were contacted again to arrange an initial interview.

In the first interview, we asked students to complete two assessments, as explained in the following sections, to evaluate their OIC and mental frames. We also asked a series of open-ended questions relating to their understanding of entrepreneurship and their perceptions of their OICs. For instance, we asked them to explain what entrepreneurs do and how they do it, whether they considered themselves creative, or entrepreneurial, and how capable they thought themselves of
identifying business opportunities. The students had listened to a session explaining what entrepreneurs do and how they do it, but had not yet had experience of entrepreneurship by way of practice in identifying opportunities. As a result they found the instructions, in the main, easy to follow. We repeated the assessments and questions in the second interview and also asked the students to explain any changes in their perceptions of their capabilities and their understanding of entrepreneurship. The first round of interviews was conducted right after the first lecture of the module, and the second round of interviews was conducted 1 week after completion of the module. The module was delivered between September 2007 and December 2007. The researcher conducting the study was an observer of the module who was not part of the instructors’ team.

### Assessing Changes in Students’ OIC

Several scholars have measured or suggested how to measure OI performance by assessing the quality and quantity of the opportunities identified (Gagliò, 2004; Hills, Lumpkin, & Singh, 1997; Hills & Shrader, 1998; Shane, 2000; Shepherd & DeTienne, 2005; Singh, Hills, Hybels, & Lumpkin, 1999). Improvements in this capability have been used to measure the impact of entrepreneurship education (DeTienne & Chandler, 2004; Fiet, 2002). This approach was applied to the students at the beginning and after the end of the module, where students were asked to list any business opportunities that they could think of.

The quality of the opportunities identified was then evaluated by several habitual entrepreneurs (i.e., entrepreneurs who have started more than one business). This approach was adopted for three main reasons. First, this kind of entrepreneur has been reported as having a well-developed ability to identify opportunities (Chandler & Jansen, 1992; Fiet et al., 2004; McGrath & MacMillan, 2000). Second, they have also been reported as having identified more opportunities than novice entrepreneurs (Ucbasaran et al., 2003; Ucbasaran et al., 2006). Third, it has been observed that prior knowledge and experience of OI possessed, for example, by habitual entrepreneurs and people involved in consultancy is associated with more innovative OI (Shepherd & DeTienne, 2005). The habitual entrepreneurs used in this study are assumed to have a high level of OIC, and consequently, a better ability to evaluate opportunity quality than other possible evaluators.

Moreover, the entrepreneurs who participated in the research were experienced mentors in the course under research. They have several years of experience evaluating not only opportunities identified by British students, but also opportunities identified by international students. As a result, even though having British evaluators assessing international students may be a limitation here, we argue that the years of experience of the mentors in working with international students helped to minimize this limitation.

Previous studies evaluating opportunity quality have used two (DeTienne & Chandler, 2004; Shepherd & DeTienne, 2005) or three (Fiet, 2002) opportunity quality evaluators. In this research the number of habitual entrepreneurs evaluating opportunities was five. This higher number was chosen to help to minimize potential evaluator bias (Fiet, 2002). The scale used by the habitual entrepreneurs to measure the quality of the opportunities identified was adapted from DeTienne and Chandler (2004) and Fiet (2002) and applied a 7-point scale to the following set of measures:

<table>
<thead>
<tr>
<th>British Students</th>
<th>Other Asian Students</th>
<th>British Students of Other Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male-18</td>
<td>Cristina</td>
<td>Female-17</td>
</tr>
<tr>
<td>No EE</td>
<td>Female-22</td>
<td>Indian</td>
</tr>
<tr>
<td>EI</td>
<td>Spanish</td>
<td>No EE</td>
</tr>
<tr>
<td>No EE</td>
<td>High EE</td>
<td>No EI</td>
</tr>
<tr>
<td>No EE</td>
<td>EI</td>
<td>No EE</td>
</tr>
<tr>
<td>David</td>
<td>Amparo</td>
<td>Female-18</td>
</tr>
<tr>
<td>Male-19</td>
<td>Female-21</td>
<td>Indian</td>
</tr>
<tr>
<td>High</td>
<td>Spanish</td>
<td>High EE</td>
</tr>
<tr>
<td>EE</td>
<td>Low EE</td>
<td>EI</td>
</tr>
<tr>
<td>No El</td>
<td>No El</td>
<td></td>
</tr>
<tr>
<td>Adam</td>
<td>Maciej</td>
<td>Nhu</td>
</tr>
<tr>
<td>Male-18</td>
<td>Male-22</td>
<td>Female-18</td>
</tr>
<tr>
<td>Full EE</td>
<td>Polish</td>
<td>Vietnamese</td>
</tr>
<tr>
<td>EI</td>
<td>No EE</td>
<td>High EE</td>
</tr>
<tr>
<td>EI</td>
<td>El</td>
<td>No EI</td>
</tr>
<tr>
<td>Joanna</td>
<td>Female-20</td>
<td>Indian</td>
</tr>
<tr>
<td>Polish</td>
<td>Cheap</td>
<td>Low EE</td>
</tr>
<tr>
<td>High EE</td>
<td>El</td>
<td>No EI</td>
</tr>
<tr>
<td>Stuti</td>
<td>Female-18</td>
<td>Indian</td>
</tr>
<tr>
<td>Low EE</td>
<td>El</td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Students who did not develop their OIC during the course appear bold-faced. EE = Entrepreneurial Exposure; EI = Entrepreneurial Intention.
Following the evaluations, we proceeded by conducting a qualitative analysis of the quantitative data emerging from the opportunity assessment. Although this assessment was developed originally as a quantitative measure, we argue that interesting insights also arise from the qualitative analysis of the quantitative data generated by this measure. This analytical logic is based on the idea that “qualitative research involves both data collection and data analysis” and that both steps could be qualitative or quantitative (Ghepart, 2004: 455). Therefore, quantitative data can be analyzed qualitatively (Bryman, 2004) and we argue that, by doing so, novel and interesting insights were gained, which are fundamental to better understand the phenomenon under analysis here.

Assessing Changes in Students’ OI Mental Frames

As indicated earlier, because OI mental frames are argued to have an important tacit component, we used the approach of capturing any changes through visual representation in the form of causal maps. Although more broadly used in psychology (Kearney & Hyle, 2004; Nosssiter & Biberman, 1990), visual representation is still an underused research method in management studies (Kearney & Hyle, 2004; Vince, 2008). However, this technique is argued to triangulate well with other research techniques (Kearney & Hyle, 2004; Meyer, 1991; Vince 2008; Vince & Broussine, 1996). Here we compare changes in visual representations with verbal testimony of changes in perception of OIC and understanding of entrepreneurship.

Visual representation, as a particular research technique, is a useful approach for capturing mental constructions that are not only verbal, but also visual (Stiles, 2004). This approach is useful for capturing unconscious dynamics, processes, and experiences (Vince, 1995, 2008). Visual data are argued to be useful in unveiling more copious and meaningful information that people cannot communicate verbally because it is implicit, tacit, or hard to define (Kearney & Hyle, 2004; Meyer, 1991; Vince, 1995; Vince & Broussine, 1996).

The particular type of visual representation that was used here refers to causal mapping. It has been argued that changes in students’ mental models reflect their learning of particular domain knowledge (Nadkarni, 2003), and that causal maps are a useful tool for capture (Clarkson, 2008; McDonald, Daniels, & Harris, 2004). Ambrosini and Bowman (2001) also argued that causal maps and other mental representations may be an effective technique to examine the tacit aspects of skills.

There are several forms of mapping that have associated and differing potential uses and techniques (McDonald et al., 2004); however, most mapping techniques rely strongly on the spoken word, and, as explained earlier, verbal accounts do not reflect the entirety of what people know. In contrast, it has been argued that drawings may help people to depict cognitive maps that are difficult to verbalize or describe (Meyer, 1991; Vince, 1995). The visual representation of causal maps was therefore used because it better captures the tacit aspects of OI mental frames (Clarkson, 2008). This approach allows students to represent their thoughts freely as in a mind map, a technique used to represent and reinforce learning (Buzan & Buzan, 2003). Through concepts and images, students are able to deploy the full range of their mental skills to show the associations they perceive (Buzan & Buzan, 2003). We measured this at the beginning and at the end of the course by asking students to respond to the following instruction: “Please draw what you think entrepreneurs do and how they do it.”

This methodology drew on the seminal work of Shoshana Zuboff. In the book In the Age of the Smart Machine (1988), Zuboff asked clerical workers to draw pictures to help them to express changes in their feelings after the installation of a computer system. In our research on OIC, prior- and postcourse visual representations of causal maps gave the students the opportunity to explain in graphical terms how they “saw” entrepreneurial activity at two different learning stages, thus enabling an evaluation of changes in their mental frames. To enhance the reliability of the assessment and help minimize confirmatory bias of changes in visual representations, only one author was involved in the data collection (Doz, 1996).
RESULTS

Changes in Students’ OIC

According to the opportunity assessment, 12 of the 15 students under examination significantly developed their OIC. Table 2 shows the results of the opportunity assessment. The number under the label “quality of opportunities” represents the mean of the rates that the different evaluators gave to the students. Every student has two rates, the first representing the score of the first assessment conducted at the beginning of the course and the second representing the score of the second assessment conducted after the course. When a student showed a significant improvement either in quality or quantity of the opportunities identified, it suggests the development of her or his OIC.

Seven of the 12 students who developed their OIC (Amparo, Apurva, Cristina, David, Joanna, Neha, and Nicola) were able to identify both more and higher quality opportunities. Three students (Adam, Emily, and Michael), although identifying an equal number or one less opportunity in the second assessment, were able to identify much higher quality opportunities than in the first. Two students (Maciej and Nhu), although identifying opportunities of a similar quality in both assessments, were able to identify many more opportunities in the second.

From the qualitative examination of the opportunity assessment, we identified three levels of development among the students who developed their OIC during the course: level 1, from nothing to something; level 2, from some to several; and level 3, from quantity to quality (see Table 2). The five students who experienced an OIC development level 1 were not able to think of any opportunity in their first assessment or were able to identify just one product or service identical to an existing one. However, in the second assessment they start to identify opportunities as well as opportunities with a higher level of innovation. For example, three students were not able

### Table 2
Assessment of OIC Development

<table>
<thead>
<tr>
<th>Participants</th>
<th>Number of Opportunities</th>
<th>Quality of Opportunities</th>
<th>Development?</th>
<th>Level of Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adam 1</td>
<td>4</td>
<td>1.95</td>
<td>Yes</td>
<td>3</td>
</tr>
<tr>
<td>Adam 2</td>
<td>3</td>
<td>3.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amparo 1</td>
<td>1</td>
<td>0.80</td>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>Amparo 2</td>
<td>2</td>
<td>1.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apurva 1</td>
<td>1</td>
<td>1.80</td>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>Apurva 2</td>
<td>2</td>
<td>2.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christopher 1</td>
<td>2</td>
<td>2.70</td>
<td>No</td>
<td>—</td>
</tr>
<tr>
<td>Christopher 2</td>
<td>1</td>
<td>1.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cristina 1</td>
<td>2</td>
<td>2.00</td>
<td>Yes</td>
<td>3</td>
</tr>
<tr>
<td>Cristina 2</td>
<td>3</td>
<td>2.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>David 1</td>
<td>2</td>
<td>1.50</td>
<td>Yes</td>
<td>2</td>
</tr>
<tr>
<td>David 2</td>
<td>6</td>
<td>1.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emily 1</td>
<td>5</td>
<td>1.68</td>
<td>Yes</td>
<td>3</td>
</tr>
<tr>
<td>Emily 2</td>
<td>4</td>
<td>2.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hei Man 1</td>
<td>3</td>
<td>1.80</td>
<td>No</td>
<td>—</td>
</tr>
<tr>
<td>Hei Man 2</td>
<td>1</td>
<td>2.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joanna 1</td>
<td>0</td>
<td>0.00</td>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>Joanna 2</td>
<td>2</td>
<td>0.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maciej 1</td>
<td>4</td>
<td>2.25</td>
<td>Yes</td>
<td>2</td>
</tr>
<tr>
<td>Maciej 2</td>
<td>8</td>
<td>2.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michael 1</td>
<td>3</td>
<td>1.67</td>
<td>Yes</td>
<td>3</td>
</tr>
<tr>
<td>Michael 2</td>
<td>3</td>
<td>2.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neha 1</td>
<td>0</td>
<td>0.00</td>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>Neha 2</td>
<td>4</td>
<td>2.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nhu 1</td>
<td>7</td>
<td>1.74</td>
<td>Yes</td>
<td>2</td>
</tr>
<tr>
<td>Nhu 2</td>
<td>10</td>
<td>1.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nicola 1</td>
<td>0</td>
<td>0.00</td>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>Nicola 2</td>
<td>5</td>
<td>1.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stuti 1</td>
<td>2</td>
<td>2.10</td>
<td>No</td>
<td>—</td>
</tr>
<tr>
<td>Stuti 2</td>
<td>2</td>
<td>2.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Students who did not develop their OIC during the course appear bold-faced.
to think of any opportunities in the first assessment, but in the second, they identified between two and five opportunities. In sum, the OIC development assessment showed that some students who were not able to think of opportunities before the course began to be able to identify opportunities after the course.

The three students who experienced an OIC development level 2, although able to identify opportunities in their first assessment, significantly increased the number of opportunities identified in the second assessment. Thus, one student increased from two to six opportunities (David), another student increased from four to eight opportunities (Maciej), and yet another increased from seven to ten opportunities (Nhu). These students mainly identified opportunities of an allocative nature, that is, opportunities which were not very innovative, but that fill market gaps with ideas already developed in other markets. In sum, the course made these students more able to recognize a specific type of opportunity.

The students who experienced OIC development level 3, although able to identify opportunities in the first assessment, were the students who showed the highest increase in quality of opportunities identified in the second assessment. For example one student (Adam) identified opportunities that were in the range of products or services identical or similar to existing ones in the first assessment. In the second assessment, he identified opportunities that were in the range of new applications to existing products or services as well as significant improvements to new products or services. In sum, the course helped these students evolve their ability to identify opportunities with a higher level of innovation.

From the perspective of the degree discipline, entrepreneurial intention, prior entrepreneurial exposure, gender, and cultural background of the students, we observed that the students who developed their OIC during the course have a variety of characteristics. This supports the evidence also reported in previous studies that OI can be delivered in the entrepreneurship classroom and that OI can be learned by students from very different backgrounds.

Only three students were considered as not having significantly developed their OIC. One (Christopher), identified fewer and lower quality opportunities in the second assessment. The final two students (Hei Man and Stuti), although increasing slightly the quality of the opportunities, identified the same number or fewer.

**Changes in Students’ OI Mental Frames: Visual Representations**

When students’ OIC development is compared with changes in their mental frames measured by visual representations, strong confirmatory evidence emerges. The 12 students who significantly developed their OIC during the course were also those whose visual representations changed the most from their first to their last drawings. Similarly, students who did not significantly develop their OIC during the module did not show significant changes in their visual representations from the first to the last drawings. Examples of changes between first and last drawings of four students (two students who developed their OIC during the module and two students who did not develop their OIC during the module) are shown below in Figures 1–8.

To analyze the drawings, we used three main criteria to observe differences between first and last drawings: graphical changes, static/dynamic views, and predominant themes. We included these criteria to provide different perspectives of analysis. Two of these analytical procedures were adapted from previous work. We developed the third. The graphical changes criterion was adapted from previous studies in which the analytical focus was oriented to capture the power of the image (i.e., Stiles, 2004; Zuboff, 2008). The changes in themes criterion was adapted from the more traditional causal maps analytical approaches oriented to capture changes in the way people relate concepts (i.e., Ambrosini & Bowman, 2001; Nadkarni, 2003). Finally, we developed a third criterion oriented to observe changes from static views to dynamic views in order to explore whether another kind of change in visual representation will better capture the way students may change their perceptions of reality.

However, our findings indicate that the most insightful approach to interpret our visual data was first, to see radical changes in drawings—our first criterion—and second, to triangulate these findings with the other data. We found that the most appropriate way of analyzing visual representation to reflect changing mental frames was actually to focus on radical visual changes in graphical representations rather than the other measures used (or indeed, verbal testimony from the students). On reflection, this was not surprising since this criterion was based on the logic of visual representations rather than on causal maps. In this respect, the students that showed significant OIC development were also those whose visual representations changed radically from their initial to
their final drawings. By contrast, those students who did not show significant OIC development were also those whose drawings did not change at all according to this criterion. This distinction is explored further below.

The first analytical criterion of graphical changes was a straightforward analysis that observed the visual differences between drawings. It appears to be the most significant criterion for observing how students modify their perceptions of reality. The students who developed their OIC during the module radically changed their representations of entrepreneurial activity, and the students who did not only demonstrated slight changes (see Figures 1–8).

The second criterion observed the use of static (concepts) or dynamic (processes) to represent entrepreneurial activity. Among the students who developed their OIC, 8 of 12 (Amparo, Apurva, Cristina, David, Joanna, Michael, Nhu, and Nicola) evolved from a static view in the first drawings to a dynamic view in the second. The last four students who also developed their OIC (Adam, Emily, Maciej, and Neha) drew visual representations with a dynamic view both at the beginning and the end of the module. The students who did not develop their OIC did not present changes according to this criterion.

The third criterion used to analyze the drawings referred to predominant themes. According to this criterion, all students who developed their OIC demonstrated significant changes in their predominant themes. Four (Amparo, Emily, Neha, and Nicola), drew their first drawings based on the concept of idea and their second on the more complex concept of creative problem solving (CPS), which assumes consumer needs as problems and potential business ideas as solutions to those problems.

In terms of the research methodology, the criteria of static/dynamic view and themes did not provide
such strong evidence as the first criterion based on examining graphical changes in visual representations. For example, the third criterion of predominant theme, which relied mainly upon written words, did not provide a clear distinction between those students who developed their OIC and those who did not. This highlights the potential value of visual representation as a research technique, and specifically, the analysis of radical visual changes to capture data that may be less accessible using traditional research methods and mapping techniques that rely on written or spoken words.

Changes in Students’ OI Mental Frames: Verbal Testimony

When we compare these visual changes to verbal testimony from the students regarding their views...
of changes in capability and understanding of OIC, the limitations of verbal testimony are highlighted. Nevertheless, verbal testimony does add some insights about the changes in students’ mental frames.

First, students appear remarkably unreliable at evaluating their OIC and any changes in that capability. As highlighted in Table 3, all the students thought that their capability had improved as a result of taking part in the course. This does not appear to be reflected in their OIC changes as evaluated by the habitual entrepreneurs. Thus, Christopher and Stuti, students who according to the opportunity assessment did not develop their OIC, nevertheless reported that after the course they were more alert to opportunities or more capable of identifying them:

Christopher: “Definitively, because it’s just in the front of your mind and just knowing that somebody would like the idea that you came up with last time just makes you think that.”

Stuti: “Possibly more (…) Because you are forced to think about different ideas. Yeah, I think more because you start think in different ways; you put yourself in the people’s shoes.”

Adam and Neha, students with a significant OIC change, thought they were only slightly better:

Adam: “maybe a bit more I guess (…) because we have to try to think about all the problems and stuff and maybe it’s broaden my mind a bit more to think in this things and if you think about the problem, then you have to be more alert to identify the solution for this.”

Neha: “Yes a little more because you are aware of what areas have to be looked at to check whether the problem is good or not. So even if I don’t do research, even if I think about it for like fifteen, twenty minutes quietly then I will know that this, this and this have to be considered.”

Second, according to the students they all have an increased understanding of entrepreneurship following completion of the course (See Table 4). Here, Nicola and Neha, students that significantly improved their OIC and changed their visual representation of entrepreneurship, showed an insight into entrepreneurship with a specific focus upon how entrepreneurs identify opportunities.

Neha: “I’ve learnt two things: the whole “how do entrepreneurs do it”… “I’m more capable of identifying high quality business opportunities from something that is not going to work because from the mentors I have learnt the way they think.”

Nicola: “I think I gained a lot more knowledge about how to develop ideas properly, how to think about it, how you would develop ideas.”

By contrast, Hei Man and Stuti, students that did not enhance their OIC or change their visual representation, only commented on their increased understanding of what entrepreneurs do:

Hei Man: “I know more about entrepreneurs and what they do, but apart from that, no. Now I know what they do”… “Just the knowledge of being an entrepreneur, but not really something I can really use.”

Stuti: “An insight into entrepreneurship.”

Finally, when students were asked to reflect upon their OIC development, some insights were provided regarding what changes in mental frames had taken place (see Table 3). Here Emily and Nhu, students who had significantly developed their OIC, talked about changes in perceiving reality and interpreting information regarding business opportunities:

Emily: “I think more because when walking somewhere like I do think about things like ‘it would be good have a business here’ or something to sell to these people or whatever.”

Nhu: “It’s just like you have the ability of like justifying if it’s is good or bad and… I don’t know how to explain it to you (…) it is like when you look at something, it is just natural that you can make money for you. I mean it’s quicker for me now.”

It appears that verbal testimony presents a somewhat confused picture where students appear to be able to reflect upon some aspects of changes in their mental frames and understanding of entrepreneurship. However, they do not appear to be able to reliably account for changes in their OIC performance.

Considering the totality of empirical evidence, it appears that students who were clearly judged to have developed their OIC were also those who made the most significant changes in their visual
### TABLE 3

**Students’ Reflections on Changes in Their OIC and OI Mental Frames**

<table>
<thead>
<tr>
<th>Participants</th>
<th>Extracts from Students’ Interviews</th>
<th>OIC Development</th>
<th>Changes in OI Mental Frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adam</td>
<td>“maybe a bit more I guess (. . .) because we have to try to think about all the problems and stuff and maybe it’s broaden my mind a bit more to think in this things and if you think about the problem, then you have to be more alert to identify the solution for this”</td>
<td>“a bit more”</td>
<td>“it’s broaden my mind a bit more”</td>
</tr>
<tr>
<td>Amparo</td>
<td>“More (. . .) because now when I’m working and I see something, I think: ‘wow this is a problem to solve’”</td>
<td>“More”</td>
<td>“now when I’m working and I see something, I think”</td>
</tr>
<tr>
<td>Apurva</td>
<td>“I think I am more (. . .) like the mentors, when they gave us a direction of the top of the head, they can evaluate things very easily. Looking at that, when I saw that happening and also when we started thinking of different problems and different solutions to the problem that we had, if tried doing that and then I realised: ‘oh’, I mean, if you think about it, you can figure out if this is a good opportunity or not and, you know, if people would accept it or not, and if it would be feasible or not”</td>
<td>“I think I am more”</td>
<td></td>
</tr>
<tr>
<td>Christopher</td>
<td>“Definitively, because it’s just in the front of your mind and just knowing that somebody would like the idea that you came up with last time just makes you think that”</td>
<td>“Definitively”</td>
<td>“it’s just in the front of your mind”</td>
</tr>
<tr>
<td>Cristina</td>
<td>“More, because (. . .) it’s true that I try to see things with other eyes, like: ‘Oh this is good, this is bad, this is a possibility’. So, I think I’m more”</td>
<td>“More”</td>
<td>“it’s true that I try to see things with other eyes”</td>
</tr>
<tr>
<td>David</td>
<td>“Yeah more, in percentage about forty fifty percent more”</td>
<td>“Yeah more”</td>
<td></td>
</tr>
<tr>
<td>Emily</td>
<td>“I think more because when walking somewhere like I do think about things like ‘it would be good have a business here’ or something to sell to these people or whatever”</td>
<td>“I think more”</td>
<td>“when walking somewhere I think: ‘it would be good have a business here’”</td>
</tr>
<tr>
<td>Hei Man</td>
<td>“Like when I go out and I see something: ‘Oh this is maybe a chance, but I can’t do this because I haven’t got the money’, and I don’t know whether it would be good or not, but if I’ve got the money I can do it”</td>
<td>“Like when I go out and I see something: “Oh this is maybe a chance”</td>
<td>“Like when I go out and I see something: ‘Oh this is maybe a chance’”</td>
</tr>
<tr>
<td>Joanna</td>
<td>“Seeing opportunities like inventing, like thinking of an innovation and like thinking of opportunities that this innovation could bring to other people, maybe in this way; so, say yes (. . .) when it comes to opportunities like innovations of something I think I have become more alert to those kinds of opportunities”</td>
<td>“Seeing opportunities like inventing, like thinking of an innovation and like thinking of opportunities”</td>
<td></td>
</tr>
<tr>
<td>Maciej</td>
<td>“I feel totally more alert to opportunity because now I don’t wait for the opportunity to see me; I try to see the opportunities and it turns out that there are a lot of opportunities out there”</td>
<td>“I feel totally more alert to opportunity because now”</td>
<td>“now I don’t wait for the opportunity to see me; I try to see the opportunities”</td>
</tr>
<tr>
<td>Michael</td>
<td>“Now if I walk into town or something I just think: “I think they could improve that by doing this”</td>
<td>“Now if I walk into town . . . I just think: “. . . they could improve that by doing this”</td>
<td>“Now if I walk into town . . . I just think: ‘. . . they could improve that by doing this’”</td>
</tr>
<tr>
<td>Neha</td>
<td>“Yes a little more because you are aware of what areas have to be looked at to check whether the problem is good or not. So even if I don’t do research, even if I think about it for like fifteen, twenty minutes quietly then I will know that this, this and this have to be considered”</td>
<td>“Yes a little more”</td>
<td></td>
</tr>
</tbody>
</table>

*(table continues)*
representations, while the opposite applied to those judged not to have developed their OIC. Such a distinction was less evident when considering verbal testimony from the students. This evidence supports our initial proposition that “Students who develop their OIC during an entrepreneurship course will also show significant changes in their mental frames regarding entrepreneurial activity.” The following discussion now considers the implications of our evidence for theory and practice.

DISCUSSION

Our findings provide evidence to support the idea that OIC can be developed. The findings also support the idea that it is not only the exposure to a certain environment that makes individuals more capable of identifying opportunities, but also the effect that these experiences have on the way individuals perceive reality and act upon it. This research suggests that OIC development in the context of entrepreneurship education will also show significant changes in their mental frames regarding entrepreneurial activity.” The following discussion now considers the implications of our evidence for theory and practice.

These findings also support the idea that whatever the background and prior entrepreneurial exposure of the students, most of them are capable of developing their OIC significantly after completing an entrepreneurship module designed to enhance OI. The results also suggest reasons why some courses appear to be more effective than others in helping people to identify opportunities. Entrepreneurship education may have a greater impact on students when it affects those often tacit factors related to the way learners perceive and act upon reality when identifying opportunities.

We argue that for entrepreneurship education to maximize its contribution, it should focus on developing entrepreneurial mental frames, an approach that could also provide insights into how to enhance learning of many other capabilities. For example, to learn some words or sentences in another language simply requires a good memory. However, if students wish to master any language they need not only to learn many more words or sentences, they need to learn to communicate in a completely different way, as every language has

### TABLE 3
Continued

<table>
<thead>
<tr>
<th>Participants</th>
<th>Extracts from Students’ Interviews</th>
<th>OIC Development</th>
<th>Changes in OI Mental Frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nhu</td>
<td>“It’s just like you have the ability of like justifying if it’s is good or bad and... I don’t know how to explain it to you (...) it is like when you look at something, it is just natural that you can make money for you. I mean it’s quicker for me now”</td>
<td>“I mean it’s quicker for me now”</td>
<td>“it is like when you look at something, it is just natural that you can make money for you”</td>
</tr>
<tr>
<td>Nicola</td>
<td>“I’m definitely a lot more alert because I never used to... I used to think of stuff before, but I never used to properly think about it, it was just a kind of a passing thought, not really thinking of anything as an opportunity, just general thinking”</td>
<td>“I’m definitely a lot more alert”</td>
<td></td>
</tr>
<tr>
<td>Stuti</td>
<td>“Possibly more (...) Because you are forced to think about different ideas. Yeah, I think more because you start think in different ways; you put yourself in the people’s shoes”</td>
<td>“Possibly more”</td>
<td>“you start think in different ways”</td>
</tr>
</tbody>
</table>

Note. Students who did not develop their OIC during the course appear bold-faced. Used with permission.
### TABLE 4

**Students' Reflections on Changes in Their Understanding of Entrepreneurial Activity**

<table>
<thead>
<tr>
<th>Participants</th>
<th>Extracts From Students’ Interviews</th>
<th>Emphasis on What Entrepreneurs Do</th>
<th>Emphasis on How Entrepreneurs Do It</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adam</td>
<td>“Well, I think many different ways of entrepreneurs do this. They all have different methods . . . there have to be a vision, and idea at the beginning and then perhaps several steps which they take to try to achieve that goal. I think there always have to have a creative vision at the beginning”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Amparo</td>
<td>“They (entrepreneurs) look for this problem and then they try to look for the easiest solution, they create solutions to do a business to make money”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Apurva</td>
<td>“Seeing things more from the perspective of an entrepreneur than from a perspective of a common man”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Christopher</td>
<td>“Being and entrepreneur is more of a way of life than just always being alert to possible business ideas and just every time that something which they feel isn’t met, having the courage and put it into on creating a business to run the product”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Cristina</td>
<td>“I have learnt from the opinions of the mentors and other people to analyse ideas. I think that is the same when you read or hear more people; at the end you have more possibilities”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>David</td>
<td>“I think the idea of grasping new product and ideas and the whole idea of teamwork and how you can go from one idea to the next and how effective brainstorming is”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Emily</td>
<td>“I think I gained more of a sense of what you need to do (to identify opportunities), just knowing more about what that process was, that was helpful”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Hei Man</td>
<td>“I know more about entrepreneurs and what they do, but apart from that, no. Now I know what they do”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Joanna</td>
<td>“I think they first have ideas; they are on the trade to, you know, to come up with innovative ideas, they would like change the world, they would like to improve people’s lives and basically in relation to products, they want to make life easier for people and more beneficial, so I think is their innovativeness and their creativeness that help them to implement products that would meet unmet consumer needs and so on”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Maciej</td>
<td>“I saw the way they think and their ability to assess ideas. I understood better how they have to think and work”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Michael</td>
<td>“I think entrepreneurs come up with creative ideas and analyse all the risk involved and analyse whether is possible or practical to do in real life and then if their analyses says that it would be a good idea to do then they have to be careful in implementing it and do research before hand to be sure”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Neha</td>
<td>“I’ve learnt two things: the whole “how do entrepreneurs do it . . . from the mentors I have learnt the way they think . . . now after talking to someone along the same line it helped me to understand this better”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Nhu</td>
<td>“It’s by learning from the mentors actually like I have never thought . . . I mean even though we studied everything in different ways in the lectures, but in the mentoring sessions and in the final presentation we could really see that every mentor came up with different questions and I learnt from that”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Nicola</td>
<td>“I have a lot more knowledge about how other people go about it and how I would definitively go about it”</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Stuti</td>
<td>“An insight into entrepreneurship”</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

*Note. Students who did not develop their OIC during the course appear bold-faced. Used with permission.*
its own logic in terms of grammar and meaning which requires new mental frames. Thus, when students go from English to Chinese or vice versa, they need to learn a completely different logic of communication. Most of management education is oriented to teach students how to apply certain analytical models or how to follow certain steps. We argue that our data suggests that for students to develop not only entrepreneurial capabilities, but also any managerial capability they need to develop specific mental frames rather than just a good memory for analytical models.

Our research findings have additional implications for approaches to teaching and learning. If it is accepted that entrepreneurship education should develop mental frames of students, then the current assessment regime may be inappropriate and not fit for the purpose. It seems that formal essay evaluation, and by implication, essay-based examination, may not be discerning when evaluating student OIC development. Our counterfactual evidence suggests that students can learn what entrepreneurs do and demonstrate this verbally without enhancing their OIC through changing their OI mental frames. The implications of this are that students could adequately answer an essay question on entrepreneurship without developing a capability for entrepreneurship, thus leading to the following proposition:

**Proposition 2: Students can demonstrate a verbal understanding of what entrepreneurs do without a corresponding development in their capability to identify new business opportunities.**

Other studies support this argument and argue that business school assessment methods are outdated relative to the needs of contemporary managers facing the challenges of globalization and ever-increasing technological change (Clarysse, Mosey, & Lambrecht, 2009). Assessment involving practitioners, visual presentation, reflection, and group work may be more effective. These components are currently present, to a limited extent, within the integrative learning model (Binks, 2005). However, it is clear that this model can be significantly enhanced once the limitations of current assessment protocols are relaxed.

This research also provides insights into alternative ways of measuring tacit aspects of knowledge and the usefulness of visual methods as research techniques. Tacit aspects of knowledge are quite problematic to assess in practice. Although there are several empirical studies claiming to have empirically assessed tacit knowledge issues (e.g., Nonaka & Takeuchi, 1995), other scholars remain sceptical about the real possibility of measuring tacit knowledge (e.g., Tsoukas, 2003). Thus, some scholars have preferred to argue for specific ways in which tacit knowledge could be operationalized (Ambrosini & Bowman, 2001; Castillo, 2002). The research findings presented above support an alternative and promising way of measuring tacit aspects of knowledge.

This research also provides evidence on the use of visual data in research methods. Visual data have been neglected and underutilized in research methods (Kearney & Hyle, 2004; Vince, 2008). They are being rediscovered in qualitative research due in part to the desire of the researcher “to go beyond the spoken word” (Flick, 2002: 159) particularly when working with issues involving tacit knowledge. Visual representation of causal maps proved an effective tool in capturing the tacit aspects underpinning the changes in students’ mental frames. This also provides additional support for the idea that visual representation is a useful approach in capturing mental constructions, which are not only verbal, but also visual (Stiles, 2004), as well as in unveiling more copious and meaningful information that people cannot communicate verbally because it is implicit or hard to define (Kearney & Hyle, 2004; Meyer, 1991; Vince, 1995; Vince & Broussine, 1996). This leads to our final proposition: **Proposition 3: Radical changes in visual representation represent a more reliable measure of changes in OI performance than the verbal testimony of students.**

**CONCLUSIONS**

We follow a diverse group of students through their teaching and learning experience during a pioneering entrepreneurship course. Following completion of the course, the majority of students developed their OIC. We argue that this development is related to a change in the students’ mental frames, a change in the way they perceive reality and the inherent opportunities therein. The empirical evidence from this research provides considerable support for these arguments and also provides implications for education theory and practice.

For education theory it provides additional evidence to support the efficacy of methodologies of integrative learning to enhance changes in OI mental frames. The research methods used also highlight research tools that have the potential to capture changes in students’ mental frames and their subsequent OIC development.

For education practice we argue that formal evaluations based upon the written or spoken
word are not adequate to fully capture OIC development in students and should be augmented or ideally replaced by methods utilizing practitioners and visual and reflective components.

Nevertheless, we acknowledge the limitations of the study. The entrepreneurship module studied is distinct and is grounded within the cultural context of a research-intensive and entrepreneurial U.K. university. Furthermore, the study examined a limited number of diverse cases; therefore, the more general applicability of the findings may be limited, and additional research is needed to better understand contextual influences upon specific groups of students, for example, the impact of cultural differences upon OIC development. The research techniques used here are in their infancy and represent a novel foray into the evaluation of student assessment and capability development. However, similar research approaches using grounded theory have been shown to yield fresh insights within the field of academic entrepreneurship (Siegel, Waldman, & Link, 2003; Siegel, Waldman, Atwater, & Link, 2004).

Finally, we argue that further research is warranted to better understand how the learning of capabilities, specifically OIC, is related to changes in mental frames. Moreover, we propose that the increased use of visual representation and practitioner assessment could reap rich rewards within educational research.

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