RESOURCE REVIEW

Developing an 'outdoor-inspired' indoor experiential mathematical activity

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Abstract

The issue of poor retention and achievement rates is one that plagues many British universities. While well documented and researched, there is still need for innovative practices to address this problem. This article outlines the theoretical underpinning of the *Activity Guide*, a tool the authors developed to support mathematics departments in order to make the transition to university easier for students and thus increase retention and attainment. Some of the topics covered here include reflective practise, experiential learning and independence; topics adapted from an outdoor frontier education course that had been specifically tailored by the authors to target and develop study skills particularly important for mathematics subjects. To allow for transferability and use by the entire higher education mathematics community the *Activity Guide* was produced to bring a similar course on university campuses, or even in classrooms, to better cater for resources and the scale the institutions' facilities allow. The *Activity Guide* contains all that lecturers will need to plan, set up and deliver a range of activities to their students.

Keywords: Experiential activities, outdoor, transition to H.E., activity guide, mathematics skills.

1. The issue of transition to university.

Modern universities are facing a well-documented problem of students entering Higher Education lacking adequate Mathematics preparation and study skills (LMS, 1995; Hawkes, 2000), for example, the concept of proof is not explained under the current A-level curriculum. The gap in academic requirements between A-level mathematics and the Higher Education courses (Hawkes, 2000) and the inability to cope with the new requirements of independence in their studies have a negative impact on their ability succeed in their university career (Cook, 1999). A summary on which factors influence retention in first year students engaged with mathematics modules can be found in Anthony (2000). A prevalent finding of research (Cook, 1999) is also that students often arrive at universities to find that the reality of the courses differs greatly from their expectations. Such students become hard-to reach, or "*inert*" (Krause, 2008); those who struggle to socially engage with peers, or lack motivation share a similar attitude. Whilst teaching the curricular knowledge of mathematics as a subject is mostly confined to the classroom, it is worthy focusing also on the other factors that can improve retention and attainment. An experiment of Cardelle-Elawar (1992) showed how teaching "*metacognitive skills*" (such as developing systematic strategies in problem solving, reflection and monitoring one's own progress) (Flavell, 1979) increased the success rate of low-achieving students. We will refer to metacognitive skills simply as skills later on, to distinguish from what is commonly understood as 'mathematical skills' (i.e. numeracy, knowledge of the subject…).

Universities employ various support mechanisms and tools in an attempt to bridge the gap in knowledge, in study skills and ability to be an independent learner between sixth form study and what is expected of an undergraduate. Some examples are a PASS (Personal Academic Support System) mentoring system, mathematics support centres, organised study groups and personal tutors.

We want to add a new tool to this pool of resources, which can be employed to improve retention and help students in mathematics courses and courses with mathematics components in this transition: an outdoor leadership inspired crash course. Such a course will make students experience some of the new demands of higher education and make them reflect on how they can best approach the problems (difficulties in understanding, organizational, etc.) which inevitably will appear during their course of study (Hawkes, 2000).

2. Why experiential learning and an outdoor course?

Experiential learning was introduced by Kolb (1984), who hypotheses that learning is not a static process but follows a cycle of having a concrete experience, reflecting on it, conceptualizing the experience (and thus realise the possible implications or developments stemming from this reflection), and applying this newly gained knowledge.

The use of the outdoors as an educational tool is not a new phenomenon. Tracing the lineage of using the outdoors as a learning tool is rather difficult. The conception of organised outdoor learning is often credited to the Scouting movement in the early nineteenth century, led by Lord Robert Baden-Powell. Other instrumental figures in the development of outdoor education (i.e. experiential learning in the outdoors) of individuals include the writer John Muir (active in the second half of the 19^{th} century), Kurt Hahn (founder of outdoor-based educational organization Outward Bound in 1941) and Joshua Miner (who brought Outward Bound to the US in 1961), to name but a few. These individuals have been incredibly influential in the acknowledgement and development of transferability of outdoor education to the workplace.

However, some of the greatest human endeavours of physical exploration (in the very name of furthering the knowledge of the human race) have come as a grander form of what one might consider traditional activities that are associated with outdoor education.

For example, if Sir Edmund Hillary (himself a keen mathematician) had not gained a simple understanding of rock climbing and geographical navigation he certainly would not have become the first human to summit Mt. Everest and reach both the North and South Pole in his lifetime. While seeming a rather far-fetched and farcical example nothing more perfectly exemplifies the fact that the outdoors, much like mathematics, will always be filled with boundaries that exist to be pushed.

The University of Central Lancashire has the advantage of an outdoor division that is structured to provide its students with high quality Frontier Education courses that are specifically aimed at using experiential learning in outdoor settings. The Frontier Education courses exist to afford undergraduates not only the opportunity to test and push their own physical boundaries in activities such as canoeing, climbing or gorge walking, but to challenge their intra and interpersonal boundaries also. These activities are alternated with experiential games, facilitation sessions and lectures on working in a team (such as Belbin's theory of team roles) (Belbin, 1981). What was not considered, though, was whether these types of courses could be tailored to target subject specific skills that would by extension lead to a greater element of transferability from the outdoor setting into the classroom, thereby maximising the impact of the experiential education. It emerged in the facilitation that some of the activities could highlight mathematics-specific aspects, which would be useful to the students during their degree (for example how to go from solving a problem for a simple specific case to describe an abstract general solution).

In the past year the authors of this article have devised a frontier education course that targets key skills, detailed in the next section, that were identified through primary research by the authors. The experiential activities, which were most significant for the skills, were identified and the three days restructured to cater for more facilitation sessions on identifying problems students are encountering, reflecting on the activities and seeing how methodologies developed in the residential course could be brought back in the classroom. The importance of the topic of team work, although still present, was reduced as not as prominent for mathematics courses as for other subjects offered. This new course is now being delivered to the first year mathematics undergraduates.

3. The skills of a successful mathematics undergraduate

The skills which mathematics students need to develop once they start a degree is a field that has been extensively researched (Whimbley 1984, Silver 1987, Schoenfeld 1992). However, it would seem that there is still a very real issue of mathematics students not succeeding in graduating. (In the report of the National Audit Office (2007), mathematics and computer science subjects are identified as a major contributor to low retention rates). While the instance of students not achieving due to personal, financial or medical reasons is a major factor in this, there is still certainly instances of students failing to gain the academic standards required in a Higher Education setting (Johnston, 1997).

This incongruence of educational literature and what actually happens in universities indicates that either universities are failing to equip all students with the appropriate skills with which to graduate, or some students are simply not engaging with the mathematical education and therefore fall behind. Either way it is the role of educational establishments to afford its students the greatest opportunity to develop the skills needed to be able to gain knowledge of the subject and thus to succeed.

It is impossible, however, to give a universal recipe, which will enable students doing mathematics modules to develop the needed set of skills. There is no ticking-the-box exercise to guarantee success. We therefore asked both the lecturers and the students at the later stages of their mathematics degree at the University of Central Lancashire the following questions:

1. What characteristics do you think you need as a mathematician?
2. What did you struggle with when you first came to university?
3. What do you do when you approach a new problem (mathematical or otherwise)?

(For lecturers, the second question was reworded “What do you think first year students struggle with?”). The questions were presented in the form of a questionnaire, or an informal interview, and allowed the authors to gather some data from students who had recently terminated their school studies in UK; whilst much of the literature is based in other countries, which have a different school system. The experience of these students whom had almost completed their journey from A-Levels to graduation, staff opinions and literature such as (Anthony, 2000; Johnston, 1997; Shaw, 1997) were pivotal to gauging what was essential to the successful mathematics undergraduate. We applied Interpretative Phenomenological Analysis (IPA) to the surveys and the interviews, and then compared the results with those found in (Anthony, 2000; Johnston, 1997; Shaw, 1997).

The resulting skills list is as follows:

Abstract thinking. New students starting a mathematics degree at university commonly expect computationally harder versions of the standard problems that they are familiar with from secondary and further education (findings from the surveys). They therefore struggle to work with abstract ideas and the concept of proof, which were absent in their previous education. Higher levels of abstractions (pattern recognition, capacity of developing memory schemata) (Silver 1987) are fundamental to approach complex problems and to fully understand theorems.

Thinking out-of-the box. Students need to not only be able to solve problems with previously explained methods, but also to create new methods to solve unfamiliar problems. First year students generally have the habit of looking for similar problems in notes and tutorial sheets and then replicate the resolutions found to what they have been presented with, giving up when they cannot find the supporting material. (Findings from the surveys).

Resilience (Gavriel, 2015). Working on new problems without a resolutive guideline requires time and persistence despite inevitable failed attempts; it is therefore needed to develop resilience at an early stage of the studies. (Findings from the surveys).

Ability to understand threshold concepts (Meyer and Land, 2005). The development of resilience in a student aids in comprehending a threshold concept. Threshold concepts refer to students understanding or comprehending an idea or theory that is necessary to the progression of their studies, but which is somewhat counterintuitive or new to the students' experience, and therefore requires a "*liminal phase*" of questioning their own knowledge and a final mental shift to fully grasp the concept. Classic examples are the concept of 'limit' and 'imaginary number', which might be a struggle to understand to begin with but become tools underpinning the entire mathematics degree.

Team work/Collaboration. Students need to be open and willing to work with, or take advice from, other students. Generally, all people tend to learn better from people of the same intellectual level as themselves. Therefore, students need to be encouraged and prepared to work together, or even to discuss issues, as this will help them learn.

Independence (Haemmerlie, Steen and Benedicto, 1994. Field, Duffy and Huggins, 2015). As well as being willing to work with other people, students need to have the skills and ability to work individually without any help. Students that rely heavily on notes, lecturers and fellow students tend to struggle with independent thought and originality. There is a fine balance that students must find between working together and being willing to take advice and help, and having the ability to work and think on their own. (Findings from the surveys).

Resourcefulness. Being aware and prepared to use all of the resources available, even if not instructed to do so by staff. New students are accustomed to being told where to look for answers or what to use and when. The drive and ability to independently find resources besides what has been provided is what sets apart the students that are more likely to succeed in higher education. Staff also exist as a resource for students, and often students do not feel comfortable enough to interact with staff on a one to one, out-of-class hours basis. (From the collected data we inferred that students were more proactive in asking for help to the lecturers after the outdoor course, also a prevalent issue in the questionnaires to students and course leaders of Johnston (1997)).

Communication (Ellis, 2003). The ability to express ideas and concepts correctly to people of different backgrounds, age and expertise is essential to the undergraduate. Students often come into a mathematics degree assuming that they will only be working with numbers or letters. They do not expect to be involved with wordy proofs or reports. If the students are unable to articulate properly, they can fail despite having understood the concept or idea. Students need to be able to produce work that is fluent and coherent so their understanding can be accurately gauged.

Critical thinking/Mathematical thinking (Kun, N.D.). Students need to be able to analyse and evaluate a problem in order to create a sound and mathematical judgment on how to approach it. Being able to see a path through a new problem and working systematically on finding a solution is what is wanted by many employers from a mathematics graduate.

Curiosity/Being inquisitive (Sparks, 2014). Without curiosity, students will lack the drive to look beyond what is taught in the lectures. It is curiosity that encourages a student to find new and innovative methods to problems, and even motivates them to work instead of procrastinating. This curiosity also has an impact on their willingness to approach others in the search for help or collaboration and their propensity to be resilient. (Findings from surveys).

Organisation. Organisation is not only necessary for assignment deadlines and exam revision, but also the ability to maintain a good balance between work/study and enjoyment. As an undergraduate student, the ability to manage more than one module, project, assignment, and exam at once is crucial. A lack of organisation will result in deadlines being missed, lectures being unattended, notes not being reviewed, revision not starting soon enough and even maybe missing paying the rent. All these things can lead even a mathematically gifted student, to fail the degree. (Johnston, 1997).

Building on previous knowledge (Kimmerle, Moskaliuk and Cress, 2011). Being able to build on topics that students have already learned and make links across subject areas is incredibly important. Students that are unable to expand on topics that have already been covered or discussed will find it difficult to succeed in the later years in the mathematics degree. The different modules in mathematics cannot be separated completely, for example, it is very common to use general ideas from pure mathematics to solve an applied mathematics problem.

Optimization/Efficiency. Finding realistically applicable and useful methods, requiring the least number of steps/time or occupying the least amount of computer memory is a requirement for many mathematics graduates, especially is finding a job in industry. Solving problems by ‘brute force’ or ‘trial and error’ can only be a first stage and the art is in going back to the problem and obtain the result in a more efficient way.

Accuracy/Precision (Whimbley, 1984). Students need to be able to find answers that are correct or accurate to a certain degree despite time or exam pressure. This often leads to mistakes and errors that are the result of increased pressure, clumsiness or even laziness rather than the result of a lack of understanding the concept or idea. Students forget that although speed is important, accuracy is more so.

4. The creation of an indoor ‘outdoor course’.

While the new maths specific frontier education course worked in its delivery within the University of Central Lancashire’s infrastructure, its application as a student support tool for the mathematics community remained limited due to its lack of transferability across institutions that find themselves lacking the investment in activity resources, facilities and practical expertise required to execute a full three-day residential frontier education course. Feedback from **sigma** and colleagues at the 2015 CETL-MSOR conference suggested the need for an adaptation of this Frontier Education course, in order to allow it to be delivered by lecturers on campus or in a classroom environment without use of specialist equipment. The intent here is to scale down the size of the activities (by means of resources and space required) and giving lecturers the tools with which to engage students in quality reflections. The *Activity Guide* is thus a guide on how to deliver an outdoor-inspired course in a campus environment, with a list of experiential games, and guides on how to set up, how to organise the schedule of the event, and how to run facilitation sessions. The authors believe it will act as an enjoyable but effective ancillary to traditional methods of teaching.

5. A handy overview on the theory of coaching

5.1 Progressive learning

When structuring a series of activities, much like learning new concepts, one must take great care to give students a solid foundation (Bush and Smith, 2010) of multidimensional learning. These are the cognitive, affective and skill capacities dimensions (Kraiger, Ford and Salas, 1993). These aspects should be introduced, logically, from the very beginning of the programme. It is this progressive schedule that affords students the opportunity to formulate their own self-direction (Knowles, Holton and Swanson, 2012) and fosters a keenness for learning, which is key to the students 'buying in' to the process of the activities. Once solid foundations have been established then the programme can see the introduction of activities requiring greater complexity and organisation.

It is with this in mind therefore that the example timetables within the *Activity Guide* are designed in a progressive manner. All programmes will begin with icebreakers and lower level activities to firstly break down any social barriers (Mertes, 2015) between both students and staff that may hinder productivity later in the programme and academic year. This will then see the programme progress to activities that develop maths specific skills alongside student skills focussing on varying instances of independent work and collaboration.

5.2 Independence

Undergraduate education is characterised by independence. The surface occurrence of independent study fosters the development of independent thought and as a result, professional autonomy. Noble and Hames's (2012) articulation that independence is an accelerant for development appears to be confluent with the Transition to Independence Process model (Kalinyak, Gary, Killion and Suresky, 2016). Within this model, the enhancement of young individual's competencies that assist them in becoming self-sufficient is essential to this end, and as mentioned earlier, remains a necessity for tertiary education to deliver due to the gap from the demands placed on previous levels of the educational process.

The instance, therefore, of students operating away from lecturer stimuli should be commonplace in the deliverance of the *Activity Guide.* Activities have been carefully devised to enable students to do work independently and create a learning environment in which the lecturer exists simply as a resource to augment their learning process, not as the sole source of information. As such, the lecturer's conduct becomes pivotal to the development of independence. Spoon feeding students information and help may increase task achievement but as a result will increase the learner dependency (Daily and Landis, 2014) which is the exact opposite of what the *Activity Guide* is designed to do. Careful consideration therefore should be given to the Facilitation section (see section 5.5) to ensure effective deliverance of the *Activity Guide.*

5.3 Collaboration

The extent to which learning is affected by the ability of a Mathematics student to collaborate should not be underestimated. The ability to collaborate and learn from peers is confluent with the notion of active learning. Petress (2006) articulates that this is effective for the enhancement of the learning process. Not only this but the encouragement of the students to act as a community of practise (Kimble, Hildreth and Bourdon, 2008) can lead to the body of students acting independently from the lecturing staff.

The *Activity Guide* affords students the experience of working as a team to foster this sense of community. A mixture of activities whereby working together is required and optional both ensures that students collaborate but also have choice as to whether or not collaboration is appropriate to meet the demands of certain activities. This further places the responsibility for ownership of learning onto the students, making them accountable for their learning but hopefully also more confident in their ability to approach activities in a more adventurous manner.

5.4 Exploration

This desire to discover new frontiers is pivotal to the notion of creativity. Defining creativity is often one of the most difficult tasks for educators, and so its development in students often misses the metaphorical mark. Marquis and Henderson (2015) identified that individuals often contextualise creativity based on the line of work that they do. With this in mind it is fair to assert therefore that in mathematics creativity is essential to not only the development of new solutions to unfamiliar problems, but also to the transfer of knowledge across subject areas (Kirwan, 2008), the understanding of abstract concepts, development of more efficient methods for problem solutions and often the articulation of the self. All of which are essential to a successful mathematics graduate.

Therefore, the exercises within the *Activity Guide* are structured to allow the greatest amount of creative input from students as possible. It is for this reason that there is no offering of ‘ideal’ solutions to the activities. Success in the activities is not necessarily the most important outcome from the *Activity Guide*, engagement in the learning process that it enables however is. Part of this process is being creative and experimenting with ideas, exploring new concepts and ideas and making valuable contributions to attempting a solution.

5.5 Facilitation and reflection

It is appropriate that any lecturer attempting to utilise the *Activity Guide* accommodates for a shift in ethos from Teacher to Facilitator (Justice and Jamieson, 2006.Wilkinson, 2012). The facilitation comes in the form of the lecturer leading their students through a change process, and is due to the intended holistic development of the student. This therefore means that the lecturer should be focussed on creating an environment whereby this development is enabled. Part of this is an explicit focus on experiential learning, with reflective practise playing a key role in students exploring and learning meaning from their experiences.

The *Activity Guide* not only draws on academic theory surrounding reflective practice from academics such as; Borton (1970), Dewey (1963), Gibbs (1988) and Kolb (1984), but also draws on the experience of skilled outdoor professionals that make a living by delivering university level thinking from frontier education. The *Activity Guide* contains an adaptation of Rolfe, Jasper, Freshwater and Rolfe’s (2011) model for reflection both in and on action and is therefore a product of sound theory based practise. This is designed to streamline the reflective process for novice facilitators. The *Guide* provides a framework for structured reflection (in the form of a prompt sheet) and points to consider for during the activity to maximise the impact that the facilitation can have on the students.

6. Conclusion

What is clear from this project is that mathematics education is as complicated as the subject itself is. The *Activity Guide* is designed to provide lecturers with a resource and tool with which to engage students in a manner that is not usually done in universities. While fun, innovative and ‘something a bit different’, the *Activity Guide* is completely dependent on effective delivery and a conscious effort from staff to ensure that much of the focus remains on quality reflections. Without reflecting on the activities, Kolb’s cycle (Kolb, 1984) is interrupted and the possibility to help the students develop new skills from the experiences is wasted. It is imperative to understand, however, that the *Activity Guide* cannot solve all of the problems of progression. It should be used in conjunction with a range of student support tools to augment an effective student experience.

The progression of mathematical education is certainly in the hands of the higher education mathematics community. Innovative and creative ways of educating students should be prevalent at every level of mathematical education. However, universities must lead the way in these endeavours. It is our hope that, if successful in universities, the *Activity Guide* will be adapted to suit the needs of Further Education and assist in the process of producing individuals that start undergraduate study with a set of skills that allow them to hit the ground running.

7. References

Anthony, G., 2000. *Factors influencing first-year students' success in mathematics.* International Journal of Mathematical Education in Science and Technology, 31(1).

Belbin, M., 1981. *Management Teams.* London; Heinemann.

Borton, T., 1970. *Reach, touch, and teach*. New York Mcgraw-Hill.

Burrell, A., McCready, J., Munshi, Z and Penazzi, D. *Activity guide*. Available at: http://www.mathcentre.ac.uk/resources/uploaded/ucl1941-enquiry-bookletweb.pdf [Accessed 1 September 2017]

Bush, T., and Smith, K., 2010. *Introducing a programme for post-registration induction and essential skills development.* Nursing Times, 106(49-50), pp. 20-22.

Cardelle-Elawar, M., 1992. *Effect of teaching metacognitive skills to students with low mathematics ability.* Teaching and teacher education; 8(2), pp. 109-121.

Cook, A., Leckey, J., 1999. *Do expectations meet reality? A survey of changes in the first year student opinion*, Journal of Further and Higher Education, 32, pp. 157-171.

Daily, J., & Landis, B., 2014. *The journey to becoming an adult learner: From dependent to self-directed learning.* Journal of the American College of Cardiology, 64(19), pp. 2066-2068.

Dewey, J., 1963. *Experience and education*. New York: Touchstone.

Ellis, R., 2003. *Communication skills: stepladders to success for the professional*. Bristol Intellect.

Field, R., Duffy, J., and Huggins, A., 2015. Teaching Independent Learning Skills in the First Year: A Positive Psychology Strategy for Promoting Law Student Well-Being. *Journal of Learning Design*, *8*(2), pp. 1-10.

Flavell, J., 1979. *Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry.* American Psychologist, 34(10), pp. 906-911.

Gavriel, J., 2015. *Tips on inductive learning and building resilience*. Education for Primary Care, 26(5), pp. 332-334.

Gibbs, G., 1988. *Learning by doing: a guide to teaching and learning methods*. Further Education Unit.

Haemmerlie, F.M., Steen, S.C., and Benedicto, J.A., 1994. *Undergraduates' conflictual independence, adjustment, and alcohol use: The importance of the mother-student relationship*. Journal of Clinical Psychology, *50*(4), pp. 644-650.

Hawkes, T., 2000. *Measuring the mathematics problem.* Engineering Council. London: MD Savage.

Johnston, V., 1997. *Why do first year students fail to progress to their second year? An academic staff perspective.* Presented at the British Educational Research Association Annual Conference, University of York.

Justice, T., and Jamieson, D., 2006. *The facilitator's field book: step-by-step procedures, checklists and guidelines, samples and templates*. New York: AMACOM.

Kalinyak, C.M., Gary, F.A., Killion, C.M., and Suresky, M.J., 2016. *The Transition to Independence Process*. Journal of Psychosocial Nursing & Mental Health Services, 54(2), pp. 49-53.

Kimble, C., Hildreth, P.M., and Bourdon, I., 2008. *Communities of practice: creating learning environments for educators*. Charlotte, N.C: Information Age Pub.

Kimmerle, J., Moskaliuk, J., and Cress, U., 2011. *Using Wikis for Learning and Knowledge Building: Results of an Experimental Study*. Educational Technology & Society, 14(4), pp. 138-148.

Kirwan, C., 2008. *Improving learning transfer: a guide to getting more out of what you put into your training*. Aldershot, Hants, England; Burlington, VT: Ashgate.

Knowles, M.S., Holton, E.F., and Swanson, R.A., 2012. *The adult learner: the definitive classic in adult education and human resource development*. Abingdon: Routledge.

Kolb, D.A., 1984. *Experiential learning: experience as the source of learning and development*. Upper Saddle River, N.J: Prentice-Hall.

Kraiger, K., Ford, J.K., and Salas, E., 1993. Application of Cognitive, Skill-Based, and Affective Theories of Learning Outcomes to New Methods of Training Evaluation. *Journal of Applied Psychology*, 78(2), pp. 311-328.

Krause, K. and Coates, H., 2008 *Students' engagement in first-year university*, Assessment & Evaluation in Higher Education, 33(5), pp. 493-505.

Kun, J. (N.D.). *"Mathematical thinking doesn't look anything like mathematics".* Blog Post. Available at: https://j2kun.svbtle.com/mathematical-thinking-doesnt-look-like-mathematics. [Accessed 1 September 2017]

LMS (London Mathematical Society), 1995. *Tackling the Mathematics Problem*, Institute of Mathematics and its Applications, Royal Statistical Society, London, UK.

Marquis, E., and Henderson, J.A., 2015. *Teaching Creativity across Disciplines at Ontario Universities*. Canadian Journal of Higher Education, 45(1), pp.148-166.

Mertes, S.J., 2015. *Social Integration in a Community College Environment*. Community College. Journal of Research and Practice, *39*(11), pp. 1052-1064.

Meyer, J.F., and Land, R., 2005*. Threshold Concepts and Troublesome Knowledge (2): Epistemological Considerations and a Conceptual Framework for Teaching and Learning.* Higher Education: The International Journal of Higher Education and Educational Planning, 49(3), pp. 373-388.

National Audit Office, 2007. *Staying the Course: the Retention of Students in Higher Education.* HC 616 Session 2006-2007, p. 21.

Noble, C., and Hames, A., 2012. *A parent's pathway to helping her children gain their independence.* Learning Disability Practice, 15(4), pp. 36-38.

Petress, K., 2006. *An Operational Definition of Class Participation*. College Student Journal, *40*(4), pp. 821-823.

Rolfe, G., Jasper, M., Freshwater, D., and Rolfe, G., 2011. *Critical reflection in practice: generating knowledge for care*. Basingstoke: Palgrave Macmillan.

Shaw, C., and Shaw, V., 1997. *First-year students' attitudes to mathematics*, International Journal of Mathematical Education in Science and Technology, 28(2), pp. 289-301.

Schoenfeld, A., 1992. *Learning to think mathematically: problem solving, metacognition, and sense making in mathematics.* In “Handbook for Research on Mathematics Teaching and Learning” Grouws (eds.), New York, Macmillan.

Silver, E., 1987. *Foundations of cognitive theory and research for mathematics problem-solving instruction*. In “Cognitive science and mathematics education, A. Schoenfeld (eds.), pp. 111-131, Hillsdale, NJ, Erlbaum.

Whimbley, A., 1984. *The key to higher order thinking is precise processing*. Educational leadership, 42, pp. 66-70.

Wilkinson, M., 2012. *The secrets of facilitation: The SMART guide to getting results with groups.* San Francisco, CA.