COMPUTER ETHICS IN BRICKS

Gosia Plotka, Bartosz Marcinkowski

De Montfort University (United Kingdom), University of Gdansk (Poland)

malgorzata.plotka@dmu.ac.uk; bartosz.marcinkowski@ug.edu.pl

ABSTRACT

It has been recognised that students of Information & Communication Technologies (ICT) tend to find their majors more of a challenge than their peers from any other course. That has a significant impact on their retention and engagement within the subject taught. What makes the content difficult to grasp is the fact that it is usually full of abstractive concepts that students tend to silo from those learnt on different modules, so they miss their chance to build an in-deep understanding of the topic. Hence, threshold concepts have been introduced to help students focus on what is vital and construct their understanding of the topic by organising troublesome content. Teaching social, ethical, and professional aspects of ICT additionally requires bringing up different perspectives to give learners the ability to discuss – and reflect critically. Therefore, the paper establishes a theoretical framework for incorporating ethical and professional values into curricula and raising the awareness of students regarding the relevance of such values for their sustainable ICT professional development. The students, by engaging in communicative learning, not only build up their self-esteem but also get a space to experiment with technologies they will soon be developing and discuss any concerns that may affect their development as professionals ready to enter the labour market.

KEYWORDS: Ethics; Lego Serious Play; Curriculum; ICT; Constructivism; Threshold concept.

1. INTRODUCTION

Modern businesses are increasingly demanded by society to comply with the standards of Corporate Social Responsibility (CSR) (Kim & Han, 2019; Patrignani & Kavathatzopoulos, 2016). Not only failing to meet these standards exposes an organization to several risks – such as contributing to environmental or corruption-related scandals, consumer boycott, or even state intervention – but also prevents the organization from taking advantage of certain opportunities. Such opportunities may include, but are not limited to, increasing brand recognition, attracting investors, increase workforce commitment, retaining consumer loyalty, or improving the bottom line. Over last few weeks, together with the outbreak of COVID-19, we observe a number of examples when companies and governments are taking advantage of the situation and putting privacy and data of civilians at risk (Stein, 2020).

One might argue that computer professionals are in a specific position in the context of this trend. On the one hand, the level of their access to corporate data often makes them vital links in keeping an eye on CSR of parent organizations. On the other, they often elude institutional CSR programs due to the high demand for IT professionals on both the freelancers and start-ups

markets. Therefore, raising awareness regarding the potential impact of their decisions on individuals, society and environment among future computing professionals cannot be overestimated.

The title of this paper has been inspired by the movement called *ethics in bricks* that uses popular Lego bricks to disseminate and explain some of the ethical dilemmas and concepts on Social Media (Twitter, Facebook and Instagram). This paper aims at presenting first stages of R=T (i.e. research equals teaching) study on how to make some troublesome content popular and easier to understand and equip students in soft skills that are not the most natural one for those studying computer science. It is computer ethics that is among the topics covered by such content. The originality of the research lies in:

- identifying the needs of different stakeholders involved in the educational process – including students, teachers, Information & Communication Technologies (ICT) industry, society, and professional bodies like BCS, IEEE, or ACM (Tassone et al., 2018; Voskoglou & Buckley, 2012);
- putting the threshold concept, fundamental ideas, and transformative learning as lenses that helped the researchers to see the face value of explored phenomena to work;
- seeking the synergy of multiple methods – including Design Thinking (DT), i.e. a solution-based approach to finding what would-be users really need (Dam & Siang, 2018);
- adoption of the Lego Serious Play and reframing.

Following the Introduction, the contributors provide an overview of the problem and related literature studies in section 2. The third section outlines the research approach taken. Next, the theoretical framework for this research is elaborated. The framework aims at delivering a set of guidelines on how ethical and professional values should be incorporated into curricula and presented to students, so they see such values as must-have competencies for their sustainable development that meets today's and future job market needs. The findings so far are introduced in section 5, followed by the conclusions.

2. RESEARCH BACKGROUND

2.1. Why shall we bother?

Prof. Simon Rogerson (2010) – the founder and former director of the Centre for Computing and Social Responsibility at the De Montfort University in Leicester, the first centre of such type in Europe – naming benefits and disadvantages of technological innovation claims that people becoming addicted to digital amenities are inclined to unreflectively accept them without considering or not being aware of their impact. This assessment is still valid a decade later, as confirmed by Patrignani and Whitehouse (2018). The number of domains going through a digital transformation driven by the industry, business and governments in a physical, psychological and economic way being driven by the ICT industry, business and governments. Many of those have already been discussed on several occasions during the ETHICOMP conference series. All the impact that technology may have needs to be understood and properly addressed. Didactic, social, ethical and professional aspects of computing seem to be a must for those who are entering the profession so that they are equipped in the right skillset and knowledge to make

relevant decisions in their workplaces. In his speech for Orkney College, University of the Highlands & Islands, Rogerson (2019) argues that one needs to look after the least in power, i.e. members of the society who have no capability to take care of themselves against the negative impact of technological development.

There is an expectation that computing-related courses ought to be accredited by professional bodies such as BCS to ensure that the students gain industry-standard training/skills and are prepared for employment upon graduation (Times Higher Education, 2017). Both honesty and ethicality are included on the list of skills that are highly demanded by the labour market (Chartered Management Institute, 2018; Lindley et al., 2013). Therefore, it seems to be vital to provide future computing professionals with the relevant information regarding their potential impact on individuals, society and environment (Tassone et al., 2018; Voskoglou & Buckley, 2012) on top of the knowledge on some more technical aspects of system development.

2.2. How to teach computer ethics?

Costa and Pawlak (2018) in their abstract submitted to ETHICOMP2018 summarise some previously expressed views on how practical computer ethics should look like. They bring up an assessment by Soraker (2010) who highlights that (1) the bulk of computer ethics-related literature is directed towards other computer ethicists; (2) is simply boring; (3) explore self-evident topics; (4) is irrelevant to the actual practice of software engineering. Another highlighted view comes from Connolly and Fedoruk (2014). They state that education in computer ethics is theoretically unsound and empirically under-supported. Moreover, ICT professionals need to explicitly understand the social contexts of computing – while faculty staff ought to put significantly less focus on ethical evaluation. Costa and Pawlak (2018) argue that despite the case studies, recent publications continue a strategy that features a lack of social context or people's behaviour/physiological response. Rogerson (2019), in turn, sees the value in encouraging students to debate real-life problems and try to look for both problems and solutions by discussing given topics. This approach needs to involve both rigour and justification that come from students' qualitative reflections.

The article written by Portela (2017) may come handy here. The authors describe their educational model based on Kolb's learning cycle and Gary et al.'s (2013) iterative teaching methodology. The latter integrates preparation, experimenting, reflecting and conceptualisation to evolve students' competencies and was validated in practice. Similarly, Portela's model combines:

- preparatory exercise – reading of technical articles (that requires the verbal-linguistic intelligence) or watching relevant video materials (what in turn is related to the spatial-visual intelligence);
- followed by discussions of case studies to understand the state of the art (logical intelligence);
- problem-based learning – the execution of practical exercises (bodily-kinaesthetic intelligence);
- gamification that helps to contextualise problem (spatial-visual intelligence);
- and reflection (intrapersonal intelligence).

This approach not only involves practice – but also refers to multiple intelligences theory and ways how people learn as defined by Gardner (2011). Such a mix satisfies UDL (Universal Design for Learning) principles that involve providing flexible (1) study resources; (2) ways to learn; and (3) ways to demonstrate knowledge and makes this approach even more inclusive (Marcinkowski, Carroll-Mayer & Plotka, 2020). Rogerson (2019) adapts the contributions by Confucius (450 BC) and Aristotle (349 BC) to contemporary conditions by highlighting the value of learning ICT by doing and experimenting; members of academia simply allow computing completing their courses and joining other professionals without understanding technology, its impact on the society and taking full responsibility of their actions or inaction. On top of that, participative learning is only possible should colleges and universities move from tutor- to student-led teaching, where – as observed by Carruthers (1953) – lecturers make themselves "progressively unnecessary".

3. RESEARCH APPROACH

To build pedagogical capacity in computing for the benefit of the student and future computing, we sought an answer to the following question: *what is the best way to incorporate social, ethical and professional aspects into a computing curriculum*? In this project, a multi-method approach was used. Years of domain-related practice that featured a number of empirical cases allowed the authors of the paper to make the DT a centric component of the research design. DT, as a solution-based approach that allows testing different ideas, suits well the project helps to find out what users really need (Dam & Siang, 2018). The approach to data collection was inspired by inter-relationship cycle suggested by Rowe (2002) and Weyman (2007) as it is shown in Figure 1.

Figure 1. Design Thinking.

Source: self-elaboration based on Rowe (2002)

Employing a few techniques as a part of the multi-method approach enabled examining both the current theory and practical experiences as well as opinions (Weyman, 2007). Namely, capturing different perspectives and building a bigger picture helped, in a pragmatic manner, to better understand the context of the problem. Such an approach is consistent with a number of well-described examples (Cavallo & Ireland, 2014; Merali & Allen, 2011). Therefore, the overall project in some ways requires a thoughtful and holistic approach. Also, the DT method is open for creative techniques using LSP to generate (ideation phase) and synthesis data gives very good results.

4. THEORETICAL FRAMEWORK

Development of guidelines for the computing-related curriculum that includes social, ethical and professional aspects through hands-on activities required adapting some theoretical framework. The theoretical framework is a way that any researcher looks at the world that allows him/her to get inside the problem within the investigated context. In this study that lenses that helped the researchers see the face value of explored phenomena are a combination of a threshold concept, fundamental ideas and transformative learning.

4.1. Through practitioner community to a sense of belonging and security

Students of computing courses – as per their disadvantaged background, lack of maturity or fact that computing courses are perceived as "nerdy" – are likely to struggle with identity (Gordon, 2016). This impacts their confidence and engagement with the group/content taught as well as a will to remain part of their groups (courses). As explained by Lave and Wenger (1991) in their works on practitioner community, people, students and teachers must engage fully (physically, emotionally as well as with their relations and thinking) into active learning together. That social regulation of education not only reinforces their learning and understanding the subject. It also impacts their sense of belonging and sense of security through being recognised as valid members of the group throughout their progress from newcomers to advanced participants – which helps to negotiate their identities. Such depersonalisation is understood as a change of perception of the individual in respect to the group conditions becoming a part of the group when their reach the level of their social identity that enables them to place themselves within that group, engage (Hogg & Terry, 2000).

Davies (2006) also emphasises the importance of a community that shares the same way of thinking and practise across a learning process. By interacting with people, a learner may construct their perspective on the world in line with a community point of view – but without taking ownership for their own understanding of the subject (Wenger , 1999). Unless they make a conscious decision whether they want to be part of it or stay outside of the discourse (should their way of seeing the world did not correspond with the point of view of the community), they may be unable to see the world through their lenses. This approach makes a difference between students being only able to repeat the content and those who apply it successfully. People who acquire knowledge through real-world or realistic experience (learning and acting) get a better understanding of the meaning of the subject and the world. According to Brown, Collins and Doguid (1988), even should there be an initial decrease in understanding, it eventually enables opening perspective and results in learning to become a life-long process. Building a relationship within the discipline and/or community may impact students' way of thinking about their potential more than their actual performance. Causing or reinforcing well-being and mental health is more important to those who are first-generation students enrolled in higher education (Stebleton, Soria & Huesman Jr, 2014). However, a false sense of security may lead the higher-year computing students to build on their misconception of what they know and are able to do as a result of surface knowledge (Gary, 2015). As students find difficult to link together previously acquired knowledge Gary finds it challenging to quiz students on what they may know or not, and, subsequently, encourage to transfer into deeper learning. The authors of this paper based on their practice over years observed a similar phenomenon: students, especially the knowledgeable ones, tend to be afraid of the questions that do not come directly from the coursebook and are more likely to challenge the teachers regarding their approach. The students

do not like any deviation from the way they were taught so far. Also, they like to know beforehand what questions are going to be there – so that they can prepare. They are reluctant to sail into uncharted waters because they may not succeed – expressing the fear of failure. Hence, one of the possible means to pave the way for depersonalisation could be by imposing certain rules – such as telling a coherent story behind a model, just as it takes place in Lego® Serious Play™ (LSP®) (Harn, 2018).

Why are social, ethical and professional aspects of computing any different from any subject discussed during Computer Science, Software Engineering, ICT and other similar courses? This kind of content expects students to employ lots of skills that are not usually required when completing other modules. Those skills include, but are not limited to, critical thinking, debating, evidencing their arguments and reflection. Any ethical aspects can be found contra-intuitive as they naturally allow for discussion where people may disagree about "what" to do rather than "why" to do it (Greene, 2015). Additionally, learning computer ethics requires participation in the group and approaching real-world problems – what, as previously mentioned, proves to be a significant challenge for computing students. Therefore, looking for a suitable learning tool is important to look for the one that helps properly to address that challenge.

4.2. Dealing with troublesome knowledge

The moment of "getting it" is like lighting bulb effect: students are now able to see what used to be invisible and read between the lines. Eckerdal et al. (2007) observed that effect moving from "līmen" (Latin equiv. for threshold) to lúmen (light, an opening) when learners leaving liminal space (liminality as a state of being in-between) after a while of getting stuck there or reaching an in-deep understanding of the subject. They dubbed it a sudden insight. Individuals, in line with principles of constructivism, are actively constructing their knowledge and transfer their understanding of the topic (Clancy, 2004; Eckerdal et al., 2006). However, being overloaded with new concepts, linking new and existing knowledge (moving from known to unfamiliar contexts) in silos from other related modules may lead to misconception. According to Eckerdal et al. (2006), isolating knowledge acquired across different modules does not help a student to transfer and a link between subjects the knowledge that could enable them to get an in-depth understanding of the topic. The way to overcome this problem could be by introducing threshold concepts – i.e. subsets of the core concepts in the discipline (Eckerdal, et al., 2006) that help to organise content taught and to focus on what is the most important. Nicola-Richmond, Pépin and Larkin (2018) stress that once a threshold concept is grasped, the world is changed forever. In their article, they discuss lighting bulb moments with the participants of their study run in the healthcare environment. They also observe that it is not so much about acquiring the skills and knowledge required by the curriculum but about the transition from student to professional mentality. Rogerson (2019) calls it an experimental journey of maturity: the ability to truly understand and confidently apply the knowledge into practice. In result, students not only master technical knowledge (*what*?) but do it in a way (*how*?) so they make a positive impact as well. To really understand something, it is expected from learners' not just to memorise facts and understand how to apply the rules, but rather to actively look for an opportunity to construct their knowledge based on the experience of learning with others – as only this guarantee being exposed to different perspectives (Walker, 2013). This comes very useful in teaching social, ethical and professional aspects of computing, where the learning process ought to take into account familiarising with such rules as code of ethics and conducts, applying those

in an analysed situation, but also discussing different scenarios and challenging status quo. It seems to be obvious that in order to be able to see things in a different way one needs to be exposed to different perspectives. Suggested by Gary et al. (2013) and promoted by Portela (2017), the iterative teaching methodology sets an order of delivering content in a way that process starts with a theoretical introduction of the topic and follows through group discussion of possible options, practical application, and – finally – reflection.

This research uses the threshold concept, one of the educational principles to make teaching computer ethics more effective. Threshold concepts introduced by Mayer and Land (2003) enable a new way of thinking about a phenomenon, thus enhancing the students' ability to master their subjects (Advance HE, 2015). Identification of threshold concepts may start with pinpointing a list of core ideas – like, proposed by Schwill (1994), fundamental ideas. It is worth to bring back here the vertical character of fundamental ideas that implies teaching the same aspects at different levels, with making them more and more complex by adding additional details as we progress. It can be equated to growth within a community from adept/newcomer (outsider, or a person who just joined) to a full member (insider).

Irvine and Carmichael (2009) explain that since threshold concepts depend on the context, they quickly become a point of focus to build a shared understanding of ideas covered within a practitioner or expert community – what makes them very useful in professional learning. Participation (dialogical) metaphor, unlike acquisition (monological) metaphor, requires building knowledge as a part of the community that shares the space and object of their development. That can, of course, be a practitioner community. Wegner (2011) describes it in terms of a group of people who, intentionally or incidentally, work hand in hand on a collective goal. Such a community could be an Indian tribe, rock band or students trying to understand a subject taught – as originally introduced by Lave and Wenger (1991) in their learning model. To ensure that this collective, in fact, forms a practitioner community there must be: (1) a shared interest; (2) members' cooperation while performing tasks; (3) practice involved. Concept of newcomers joining a group of professionals to learn and becoming part of the community through legitimate peripheral participation was introduced by Lave and Wenger (1991) and explored by Allen (2005). The former authors, similarly to Clouder (2005), remark usefulness of the threshold concept in confronting students with range aspects of dilemmas coming from the subject learnt. These threshold concepts could be therefore what Nissani (1995) calls distinctive components – that describe specific ways of approaching a problem for each discipline and include its important elements. It is particularly important when it comes to creating new knowledge within interdisciplinary research.

Taking different perspectives, for instance during discussing the topic with colleagues within the practitioner community, provides principles for interpreting (Mezirow, 1990). Action bereave of reflection becomes habitual while reflective action may lead to further reflection (critical reflection) on the process – such as learning. To develop critical reflection, one needs to allow their presuppositions to be challenged and revised. Therefore, a reflective thinker makes an informed decision based on collected evidence to support his/her judgment. The ability to critically see own action and inaction is crucial in understanding social, ethical and professional aspects of computing.

4.3. Lego ® Serious Play™ and reframing

As the threshold concept is often described as troublesome, knowledge teaching requires an approach that helps students with engaging effectively in their own learning process (Barton & James, 2017). Namely, using metaphors and applying active and creative methods such as Lego Serious Play and reframing seems to produce a very positive outcome. Lego® Serious Play® (LSP) is a method introduced in the '90s of the XX century by Kristiensen, Victor and Roos. It was popularised (as an open-source) in 2010 by the Lego Group to support communication and problem-solving. LSP can be used as an alternative tool to ideate (brainstorm) and conceptualise the outcomes – for example during meetings or focus groups. In LSP®, bricks become mediators that enable participants to answer even the questions that seem to be very abstract at the beginning through the story (Barton & James, 2017).

It has been recognised that cognitive processes – such as learning and memory – are highly influenced by the way people use their bodies to interact with the physical world (Gauntlett, 2010). For example, "talking and thinking with hands" by employing social constructivism principles and facilitating physical interaction with the properties of the problem in a more natural way (Vallée-Tourangeau & Vallée-Tourangeau, 2016), proved to be a powerful way of overcoming some barriers with expressing an opinion and reflecting on own work or discussed topic (Executive Discovery, 2014). Together with depersonalisation, thinking with hands makes a way to develop perspective thinking that (1) helps to embrace a diversity of learning needs; and (2) enhances the sense of security through the narrative process and reframing personal experience (Harn, 2018).

Reframing is another cognitive technique that could be successfully used to assist students in building up their confidence in their skills. It breaks a problem down into layers by going through questions: what → who → when → where → why. The approach shows similarity to the one presented in Kipling's poem *Six honest serving men* – although the latter introduces an additional question: "how". As observed by Reeve (2014) during her work with Art & Design students, this approach helps to think of study direction, the context of the problem as well as generate and synthesis new ideas. It also enables focusing on a single aspect at the time, reframing way of thinking about the subject (James & Brookfield, 2014), and, by going through different frames, visualise thought process (English, 2011). Once frames are completed, students get a better understanding of the complexity of their topic (Reeve, 2014). In turn, when they read back, the order is reversed and starts with "why" for a better storyline.

Both LSP and reframing enable people to reflect on their experiences and rethink them, ensuring their sense of security at the same time. Reframing, as a way to look at the discussed situation from a different angle, enables changing or adjusting further move towards the innovative problem-solving. According to Anderson (2019), storytelling constitutes a powerful communication tool. A story is a way to show the other person perspective. By listening or sharing a story, people develop empathy and build a relationship with each other (Snow & Lazauskas, 2018).

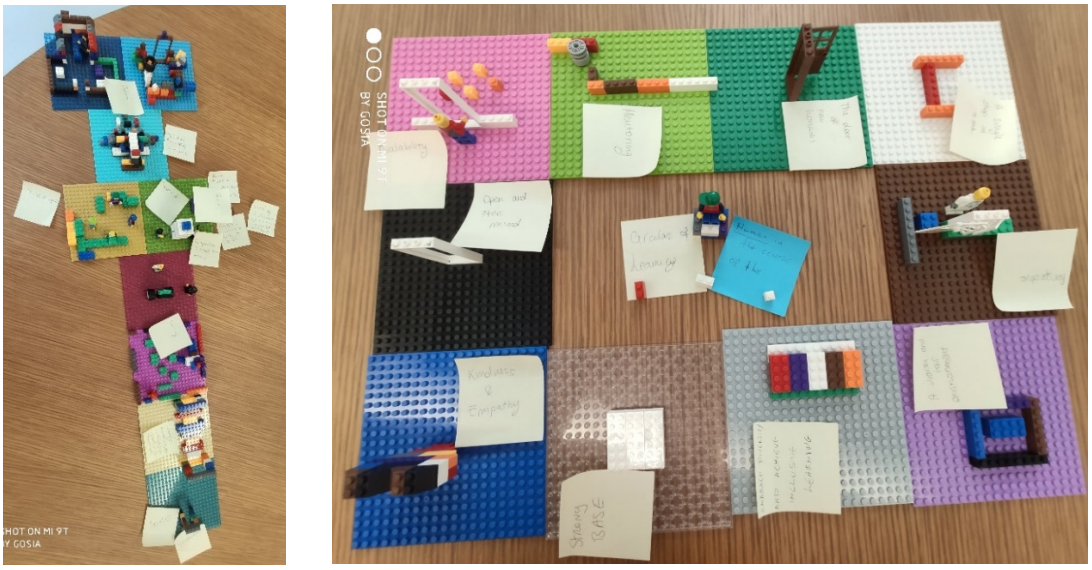
5. PRELIMINARY RESULTS

As per data collected in accordance with the adopted research approach, the authors of this paper learnt that the proposed iterative approach helps a student to achieve a lighting bulb effect. The flexibility of study resources, ways of learning and demonstrating knowledge in our

experience makes this approach truly UDL-friendly by addressing different learning needs and preferences. Not every student experienced the moment of revelation at the same point of time, or when performing the same type of activity. Some got it during more traditional activities – e.g. while answering questions set up by tutor. Others through practical activities, like building LEGO models and elaborating stories behind them, or during a reflective group discussion over their shared model. Talking through some concepts in a classroom environment helps to eliminate extremes and behaviours that are not accepted by the group. Some of the students still struggled. That said, as this approach helps them confront a sense of security and open themselves to different perspectives and needs, the number of students who may feel left behind decreases. It is the discussion on copyrights jointly with researchers that may serve as an example to back this mechanics up. Is it socially justified to download content that is not meant for open use without paying for that? Despite some legal environments that allow it for private use exclusively, the group opted for the position that individuals presenting pro-downloading arguments were just seeking to provide a rationale and to justify their theft.

One occasion when authors had a chance to apply their approach was the 90-minute-long *ACM celebration of women in computing* workshop (including methodological introduction and a hands-on activity performed by participants) in Rome, 2019. During the practical part, the participants divided into two groups of nine were asked how to build a positive ICT future and an inclusive society in the Information Age. Even though they initially found question far too abstract, they ultimately managed to come up with their own model and communicate its story to the rest of the team. And then, jointly as a group, they combined the components into a shared idea (Figure 2). Constructing models was followed up by the discussion on what is important in becoming an ICT professional with a human-centred approach.

Figure 2. ICT student pathway towards professionalism and a human-centred cycle of learning.



This event help contributors to check first hand in practice how LSP can (1) help people deal even with initially very abstractive idea, (2) bring together on the same page people from different backgrounds making creating a group out of them within a relatively short time. That

was also observed by the teachers who participated in the workshop. One of them declared to buy LEGO to use in their classroom with their students.

6. CONCLUSIONS

As both the research background and the preliminary outcomes of the study demonstrate, there is a need to create an environment where they can explore their course subjects and have an opportunity to practice what they have learnt. It is especially noticeable in the computing domain – where students seem more likely to be disengaged and fail. Knowledge transfer should be based on the practitioner community, where students can explore metaphors and discuss abstraction – as one of the leading concepts in computing. At the same time, a sense of security ought to be ensured, so students were not afraid to explore given topics. Building a practitioner community aids in teaching regular computing modules, and may help in teaching social, ethical and professional aspects of computing on top of that. As the latter might be considered highly subjective – probably more than any other subject within this domain – it is crucial that students engaged with the topic and came across perspectives different than their own. Students should become a part of a community where they are exposed to experimentation, involved in discussions, argumentation, practical tasks etc. In our humble opinion, it is the optimal way to build up critical thinking – by being a part of the community, practitioners' community in particular, and continuously engaged.

ACKNOWLEDGEMENTS

The authors of the current paper would like to extend their sincere thanks to Dorota Filipczuk and Ruth Lennon. Without their contribution, the workshop in Rome would not have a shape it ultimately had.

REFERENCES

Advance HE (2015). *Threshold Concepts*. Retrieved from https://www.heacademy.ac.uk/knowledge-hub/threshold-concepts

Allen, V. (2005). A reflection on Teaching Law to Business Students. In *Proceedings of the Society for Research into Higher Education Conference.* Edinburgh: University of Edinburgh.

Anderson, C. (2019). *Storytelling Is a Powerful Communication Tool – Here's How to Use It, from TED*. Retrieved from https://ideas.ted.com/storytelling-is-a-powerful-communication-tool-heres-how-to-use-it-from-ted

Barton, G., & James, A. (2017). Threshold Concepts, LEGO Serious Play® and Whole Systems Thinking: Towards a Combined Methodology. *Practice and Evidence of Scholarship of Teaching and Learning in Higher Education*, 12(2), 249-271.

Brown, J., Collins, A., & Duguid, P. (1988). *Situated Cognition and the Culture of Learning* [Report No. 6886]. Cambridge, MA: Bolt Beranek and Newman Inc.

Carruthers, T. J. (1953). Discipline as a Means of Development. *The Phi Delta Kappan*, 35(3), 137-139.

Cavallo, A., & Ireland, V. (2014). Preparing for Complex Interdependent Risks: A System of Systems Approach to Building Disaster Resilience. *International Journal of Disaster Risk Reduction*, 9, 181-193.

Chartered Management Institute (2018). *All University Students Must Gain Leadership Skills, Says New Employability Report.* London: Chartered Management Institute.

Clancy, M. (2004). Misconceptions and Attitudes that Interfere with Learning to Program. In S. Fincher, & M. Petre (Eds.), *Computer Science Education Research* (pp. 85-100). London: RoutledgeFalmer.

Clouder, L. (2005). Caring As a 'Threshold Concept': Transforming Students in Higher Education into Health (Care) Professionals. *Teaching in Higher Education*, 10(4), 505-517.

Connolly, R., & Fedoruk, A. (2014). Why Computing Needs to Go Beyond Good and Evil Impacts. *Proceedings of ETHICOMP 2014. Liberty and Security in an Age of ICTs*. Paris: The University of Pierre and Marie Curie.

Costa, G., & Pawlak, P. (2018). *Practical Computer Ethics – An Unsolved Puzzle! Creating, Changing, and Coalescing Ways of Life with Technologies*. Warsaw: Polish-Japanese Academy of Information Technology.

Dam, R., & Siang, T. (2018). *What Is Design Thinking and Why Is It So Popular?* Aarhus: Interaction Design Foundation.

Davies, P. (2006). Threshold Concepts: How Can We Recognise Them? In J. H. R. Meyer, & R. Land (Eds.), *Overcoming Barriers to Student Understanding: Threshold Concepts and Troublesome Knowledge* (pp. 94-108). Abingdon: Routledge.

Eckerdal, A., McCartney, R., Moström, J., Ratcliffe, M., Sanders, K., & Zander, C. (2006). Putting Threshold Concepts into Context in Computer Science Education. *ACM SIGCSE Bulletin*, 38(3), 103-107.

Eckerdal, A., McCartney, R., Moström, J., Sanders, K., Thomas, L., & Zander, C. (2007). From Limen to Lumen: Computing Students in Liminal Spaces. In *Proceedings of the Third International Workshop on Computing Education Research* (pp. 123-132). New York, NY: ACM.

English, F. (2011). *Student Writing and Genre: Reconfiguring Academic Knowledge.* London: Bloomsbury Academic.

Executive Discovery. (2014). *The Science of LEGO® SERIOUS PLAY™.* Retrieved from https://thinkjarcollective.com/wp-content/uploads/2014/09/the-science-of-lego-serious-play.pdf

Gardner, H. (2011). *Frames of Mind: The Theory of Multiple Intelligences, 3rd Edition.* New York, NY: Basic Books.

Gary, K. (2015). Project-Based Learning. *Computer*, 48(9), 98-100.

Gary, K., Lindquist, T., Bansal, S., & Ghazarian, A. (2013). A Project Spine for Software Engineering Curricular Design. *Proceedings of 26th Conference on Software Engineering Education and Training* (pp. 299-303). San Francisco: IEEE.

Gauntlett, D. (2010). *Introduction to LEGO® SERIOUS PLAY®.* Retrieved from https://davidgauntlett.com/wp-content/uploads/2013/04/LEGO_SERIOUS_PLAY_OpenSource_14mb.pdf

Gordon, N. A. (2016). *Issues in Retention and Attainment in Computer Science*. Retrieved from https://documents.advance-he.ac.uk/download/file/4652

Greene, J. (2015). Beyond Point-and-Shoot Morality: Why Cognitive (Neuro) Science Matters for Ethics. *The Law & Ethics of Human Rights*, 9(2), 141-172.

Harn, P. L. (2018). LEGO®-Based Clinical Intervention with LEGO®SERIOUS PLAY® and Six Bricks for Emotional Regulation and Cognitional Reconstruction. *Examines in Physical Medicine & Rehabilitation*, 1(3), 1-3.

Hogg, M., & Terry, D. (2000). Social Identity and Self-Categorization Processes in Organizational Contexts. *Academy of Management Review*, 25(1), 121-140.

Irvine, N., & Carmichael, P. (2009). Threshold Concepts: A Point of Focus for Practitioner Research. *Active Learning in Higher Education*, 10(2), 103-119.

James, A., & Brookfield, S. (2014). *Engaging Imagination: Helping Students Become Creative and Reflective Thinkers.* Hoboken, NJ: John Wiley & Sons.

Kim, H., & Han, J. (2019). Do Employees in a "Good" Company Comply Better with Information Security Policy? A corporate social responsibility perspective. *Information Technology & People*, 32(4), 858-875.

Lave, J., & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation.* Cambridge: Cambridge University Press.

Lindley, D., Aynsley, B., Driver, M., Godfrey, R., Hart, R., Heinrich, G., Unhelkar, B., & Wilkinson, K. (2013). Educating for Professionalism in ICT: Is Learning Ethics Professional Development? In J. Weckert, & R. Lucas (Eds.), *Professionalism in the Information and Communication Technology Industry* (pp. 211-232). Canberra: ANU Press.

Marcinkowski, B., Carroll-Mayer, M., & Plotka, M. A. (2020). Non-Attendance Factors – Can e-Learning Be Considered a Disincentive. *Information Technologies and Learning Tools*.

Meyer, J. H. F., & Land, R. (2003). Threshold Concepts and Troublesome Knowledge: Linkages to Ways of Thinking and Practising within the Disciplines. In C. Rust (Ed.), *Improving Student Learning: Theory and Practice – 10 Years On* (pp. 412-424). Oxford: Oxford Brookes University.

Merali, Y., & Allen, P. (2011). Complexity and Systems Thinking. In P. Allen, S. Maguire, & B. McKelvey (Eds.), *The Sage Handbook of Complexity and Management.* London: SAGE Publications Ltd.

Mezirow, J. (1990). How Critical Reflection Triggers Transformative Learning. *Fostering Critical Reflection in Adulthood*, 1(20), 1-6.

Nicola-Richmond, K., Pépin, G., & Larkin, H. (2018). Once You Get the Threshold Concepts the World Is Changed Forever: The Exploration of Threshold Concepts to Promote Work-Ready Occupational Therapy Graduates. *International Journal of Practice-Based Learning in Health and Social Care*, 6(1), 1-17.

Nissani, M. (1995). Fruits, Salads, and Smoothies: A Working Definition of Interdisciplinarity. *The Journal of Educational Thought (JET)/Revue de La Pensée Educative*, 121-128.

Patrignani, N., & Kavathatzopoulos, I. (2016). Cloud Computing: The Ultimate Step Towards the Virtual Enterprise? *ACM SIGCAS Computers and Society*, 45(3), 68-72.

Patrignani, N., & Whitehouse, D. (2018). Applying Slow Tech in Real Life. In N. Patrignani, & D. Whitehouse (Eds.), *In Slow Tech and ICT* (pp. 113-127). Cham: Palgrave Macmillan.

Portela, C. (2017). *Modelo Iterativo Para o Ensino de Engenharia de Software* [PhD Thesis]. Recife: Universidade Federal de Pernambuco.

Reeve, J. (2014). How Can Adopting the Materials and Environment of the Studio Engage Art & Design Students More Deeply with Research and Writing? An Investigation into the Reframing Research Technique. *Journal of Writing in Creative Practice*, 7(2), 267-281.

Rogerson, S. (2010). Ethics of Emerging Technologies. Retrieved from https://www.youtube.com/watch?v=enRARJEuBVk#

Rogerson, S. (2019). Teaching Computer Ethics. Retrieved from https://www.youtube.com/watch?v=sZWRj6G67x4

Rowe, R. (2002). A Multi-Methodological Approach to Emergency Call Handling in the Metropolitan Police Service. In G. Ragsdell, D. West, & J. Wilby (Eds.), *Systems Theory and Practice in the Knowledge Age* (pp. 79-86). New York: Springer Science+Business Media, LLC.

Schwill, A. (1994). Fundamental Ideas of Computer Science. *Bulletin European Association for Theoretical Computer Science*, 53, 274-295.

Snow, S., & Lazauskas, J. (2018). *The Storytelling Edge: How to Transform Your Business, Stop Screaming into the Void, and Make People Love You.* Hoboken, NJ: John Wiley & Sons.

Soraker, J. (2010). *Designing a Computer Ethics Course from Scratch*. Retrieved from http://www.soraker.com/designing-a-computer-ethics-course-from-scratch

Stebleton, M., Soria, K., & Huesman Jr, R. (2014). First-Generation Students' Sense of Belonging, Mental Health, and Use of Counseling Services at Public Research Universities. *Journal of College Counseling*, 17(1), 6-20.

Stein, S. (2020). *How to Restore Data Privacy After the Coronavirus Pandemic*. Retrieved from https://www.weforum.org/agenda/2020/03/restore-data-privacy-after-coronavirus-pandemic

Tassone, V. C., O'Mahony, C., McKenna, E., Eppink, H. J., & Wals, A. E. (2018). (Re-) Designing Higher Education Curricula in Times of Systemic Dysfunction: A Responsible Research and Innovation Perspective. *Higher Education*, 76(2), 337-352.

Times Higher Education (2017). *Computer Science – De Montfort University*. Retrieved from https://www.timeshighereducation.com/world-university-rankings/de-montfort-university/courses/computer-science

Vallée-Tourangeau, G., & Vallée-Tourangeau, F. (2016). Why the Best Problem-Solvers Think with Their Hands, As Well As Their Heads. *The Conversation*.

Voskoglou, M. G., & Buckley, S. (2012). Problem Solving and Computers in a Learning Environment. *Egyptian Computer Science Journal*, 36(4), 28-46.

Walker, G. (2013). A Cognitive Approach to Threshold Concepts. *Higher Education*, 65(2), 247-263.

Wenger, E. (1999). *Communities of Practice: Learning, Meaning, and Identity.* Cambridge: Cambridge University Press.

Wenger, E. (2011). *Communities of Practice: A Brief Introduction.* Cambridge: Cambridge University Press.

Weyman, T. R. (2007). *Spatial Information Sharing for Better Regional Decision Making* [PhD Thesis]. Penrith: University of Western Sydney.