

From Feedback to Features: A Two-year Comparative Study of Iterative Gamification Design in Engineering Education

Sylwia Babicz

Faculty of Electronics, Telecommunications and Informatics, Gdańsk University of Technology, Poland

sylwia.babicz@eti.pg.edu.pl

Abstract: Gamification in higher education is increasingly recognised as a promising approach to improving student engagement and long-term knowledge retention. However, evidence on the effectiveness of iteratively refined gamified systems – particularly in engineering disciplines and at scale – remains limited. This paper presents a two-year comparative study of a gamified lecture format implemented in a Metrology course at Gdańsk University of Technology, Poland, across 634 students from three degree programmes: Electronics and Telecommunications (EiT), Automatics, Cybernetics and Robotics (ACiR), and Biomedical Engineering (IBM). In the first year (2024/2025), the gamified system – titled "The Metrological Adventures of Gabryś" – replaced a traditional end-of-course test with a series of topic-based assignments incorporating risk-based task selection, narrative elements, and cumulative scoring. Students engaged with course material systematically throughout the semester rather than cramming before a single summative assessment. Following the first cohort, qualitative student feedback was collected and systematically incorporated into the system design for the following academic year. Key changes introduced for the second cohort (2025/2026) included enriched narrative content in the form of easter eggs embedded within assignments, the addition of optional practice tests prior to each graded task, and technical improvements to the task selection mechanism. Comparative analysis of learning outcomes reveals consistent and substantial improvement across all three programmes. Overall pass rates increased from 72.3% to 92.2% – a gain of nearly 20 percentage points. Mean scores rose from 26.3 to 31.7 points. Crucially, the distribution of results shifted markedly upward: whereas in 2024/2025 most students clustered just above the passing threshold, in 2025/2026 the majority achieved scores in the upper range, with 46% of ACiR students and 33% of EiT students reaching the top scoring bracket. These findings suggest that student-driven iterative refinement of gamified systems can yield significant and measurable improvements in learning outcomes. The study contributes empirical evidence – rarely available at this scale in the gamification literature – for the value of closing the feedback loop between students and course designers in technology-enhanced learning environments.

Keywords: Gamification, Engineering education, Iterative design, Learning outcomes, Student feedback, Metrology, Higher education

1. Introduction

Assessment in large-scale university courses presents a persistent challenge: how to evaluate hundreds of students in a way that is fair, manageable, and educationally meaningful. In traditional lecture-based formats, end-of-course tests remain the dominant assessment method, yet they often encourage short-term memorisation rather than deep and systematic engagement with the material (Biggs, Tang and Kennedy, 2022).

The Metrology course at the Faculty of Electronics, Telecommunications and Informatics at Gdańsk University of Technology is taught each year to approximately 300 students across three degree programmes: Electronics and Telecommunications (EiT), Automatics, Cybernetics and Robotics (ACiR), and Biomedical Engineering (IBM). Prior to the intervention described in this paper, student performance was assessed through a single summative test administered in a computer laboratory under supervisor presence, using the Moodle platform. While this approach ensured consistency and academic integrity, it placed considerable logistical demands on teaching staff – requiring coordination of approximately 50 separate test sessions – and did not encourage regular engagement with course content throughout the semester.

In the summer semester of 2024/2025, a gamified assessment system was introduced as an alternative path to course completion. The system, titled "The Metrological Adventures of Gabryś" – named after a real cat living on the university campus – replaced the single summative test with a series of topic-based assignments released progressively throughout the semester. Students accumulated points through regular engagement, with each assignment consisting of two phases: a mandatory knowledge-checking phase and an optional advanced task offering greater rewards but carrying greater risk.

Following the first year of implementation, student feedback was systematically collected and used to inform iterative improvements to the system for the 2025/2026 academic year. This paper reports on the comparative learning outcomes of two consecutive cohorts – 289 students in 2024/2025 and 345 students in

2025/2026 – examining whether student-driven refinements to the gamified system produced measurable improvements in academic performance. The increase in the second cohort reflects a larger institutional intake in 2025/2026; the difficulty level and scoring thresholds of the gamified system remained unchanged between years.

The paper is structured as follows: Section 2 reviews relevant literature on gamification in higher education. Section 3 describes the gamified system and its mechanics. Section 4 details the iterative changes introduced between cohorts. Section 5 presents the methodology. Section 6 reports results. Section 7 discusses findings and Section 8 concludes.

2. Related Work

Gamification – defined as the application of game design elements in non-game contexts (Deterding et al., 2011) – has attracted considerable scholarly attention as a strategy for improving student engagement and motivation in higher education. Systematic reviews of the field consistently report positive effects on participation, persistence, and affective outcomes, though evidence on direct impacts on learning outcomes remains more mixed (Dichev and Dicheva, 2017). Caponetto, Earp and Ott (2014) provide an early comprehensive review of gamification in education presented at ECGBL, identifying key design patterns and noting the need for more rigorous empirical evaluation.

The theoretical foundations of educational gamification draw heavily on Self-Determination Theory (Deci and Ryan, 2000), which identifies autonomy, competence, and relatedness as core drivers of intrinsic motivation. Well-designed gamified systems support all three needs: autonomy through student choice, competence through progressive challenge and immediate feedback, and relatedness through shared learning experiences. Landers (2014) further developed a theory of gamified learning, arguing that game elements influence learning outcomes indirectly by shaping attitudes and behaviours toward the learning task.

In engineering and STEM education specifically, gamification has been applied across a range of disciplines including programming, mathematics, and laboratory courses (Ibanez, Di-Serio and Delgado-Kloos, 2014). Díaz-Ramírez (2020) provides empirical evidence of positive effects of gamification on failure rates and average grades in an engineering course, using statistical analysis comparable to the present study. Studies in this context frequently highlight the value of formative, continuous assessment over single summative evaluation, particularly for courses requiring cumulative knowledge building (Hattie and Timperley, 2007; Nicol and Macfarlane-Dick, 2006).

Risk-based mechanics – where students choose between tasks of varying difficulty and reward – represent a less commonly studied but promising design element. Clifford (1988) demonstrated that moderate risk-taking in academic tasks is associated with higher motivation and greater persistence, particularly when failure carries limited penalty. Zichermann and Cunningham (2011) and Kapp (2012) identify variable reward structures as among the most powerful engagement mechanisms available to game designers, a principle increasingly applied in educational contexts.

Narrative elements and hidden content – sometimes referred to as easter eggs – have received limited attention in the gamification literature despite their potential to sustain long-term engagement. Nicholson (2015) argues that meaningful gamification requires contextual embedding of game elements within a coherent narrative framework, moving beyond superficial point-and-badge systems. The role of iterative, student-informed design in gamified courses remains particularly underexplored. Buciuman (2024), presenting at ECGBL 2024, demonstrates the value of agile iterative approaches to educational game design in engineering education, emphasising alignment of learning objectives with game mechanics through successive refinement cycles. The present study extends this line of inquiry by reporting empirical outcome data from two consecutive cohorts of a course redesigned based on systematic student feedback.

3. The Gamified System: "The Metrological Adventures of Gabryś"

The gamified assessment system introduced in the summer semester of 2024/2025 was designed around a fictional narrative centred on Gabryś – a real cat living on the campus of Gdańsk University of Technology and well known to the university community. The narrative framing served as a motivational device, giving students a sense of purpose beyond grade accumulation: their actions within the system contributed to the fictional wellbeing of Gabryś. The design and implementation of the system are described in full in Babicz (2025); the present paper focuses on the outcomes of its iterative refinement across two consecutive cohorts.

The system consisted of seven thematic modules, each corresponding to a lecture topic in the Metrology course. Modules were released sequentially, with each becoming available shortly after the corresponding lecture. Students had a defined time window in which to complete each module. The maximum achievable score across all seven modules was 40 points, and the passing threshold was set at 25 points in 2024/2025 and 24 points in 2025/2026. Each module comprised two sequential phases. The Feeding Phase required students to complete a short knowledge-verification quiz covering fundamental concepts from the corresponding lecture. Successful completion of this phase – achieving a minimum number of points, metaphorically referred to as "cans of food" for Gabryś – was a prerequisite for accessing the second phase. Students who did not meet the threshold in the Feeding Phase were unable to proceed further within that module.

The Care Phase presented students with a binary choice: a standard Task offering a lower maximum score, or a more demanding Mission offering a higher potential reward but carrying the risk of a lower score in the event of an incomplete or incorrect response. Points in this phase were referred to as "veterinary vouchers." The Care Phase tasks ranged from advanced theoretical questions to practical exercises requiring students to interpret technical datasheets, measurement equipment manuals, and engineering literature – skills directly relevant to professional engineering practice.

Importantly, the system included no social comparison mechanisms such as leaderboards or peer rankings. Engagement was driven entirely by individual motivation, narrative immersion, and the intrinsic challenge of the tasks themselves. Students could monitor their own cumulative score in real time throughout the semester.

4. Iterative Redesign Based on Student Feedback

Following the completion of the first cohort in 2024/2025, a structured feedback collection process was conducted. Students were invited to reflect on their experience of the gamified format through a questionnaire addressing perceived difficulty, motivation, narrative engagement, and satisfaction with the assessment structure. The feedback provided the basis for a set of targeted modifications introduced for the 2025/2026 cohort.

Three principal changes were implemented. First, narrative easter egg content was added to the Care Phase of each module. Upon successfully completing a Care Phase activity, students unlocked hidden narrative rewards – either a continuation of the introductory storyline or an interactive riddle embedded within the game's fictional universe. This content was not visible or accessible to students who did not complete the Care Phase, functioning as a discovery-based reward for engagement rather than a guaranteed feature of the system. The easter eggs were designed to sustain narrative immersion across the full duration of the semester, addressing feedback from the first cohort which indicated interest in a more developed storyline.

The narrative reward system was accompanied by carefully designed feedback messages for students who did not successfully complete a given phase. Students who failed to reach the required threshold in the Feeding Phase received an encouraging message indicating that, while the Care Phase remained inaccessible for that module, the next topic would offer a fresh opportunity. Similarly, students who attempted the Care Phase but did not earn at least one veterinary voucher – regardless of whether they had chosen a Task or a Mission – were informed that the narrative easter egg content for that module remained hidden, but that they were welcome to attempt to solve the embedded riddle independently. These messages were designed to preserve motivation and reduce the negative affective impact of failure, consistent with principles of autonomy-supportive feedback (Deci and Ryan, 2000) and the broader gamification literature's emphasis on failure as a recoverable state rather than a terminal outcome (Nicholson, 2015).

Second, optional practice tests were introduced prior to each graded module. These ungraded exercises allowed students to familiarise themselves with the question formats and technical content of the upcoming Feeding Phase before their performance was assessed. The practice tests were available without time limits and could be attempted multiple times, providing a low-stakes preparation pathway that was absent in the first cohort's experience. Third, the technical mechanism governing the Task/Mission selection in the Care Phase was refined to improve reliability. First-cohort feedback had identified occasional ambiguity in the selection interface, and the updated version provided clearer visual confirmation of the chosen path before submission was finalised.

The passing threshold was also adjusted marginally, from 25 points in 2024/2025 to 24 points in 2025/2026, reflecting a recalibration based on observed score distributions in the first cohort. The difficulty and content of the tasks themselves remained unchanged between years, as did the maximum achievable score of 40 points.

5. Methodology

This study employed a quasi-experimental longitudinal design, comparing learning outcomes across two consecutive cohorts of students enrolled in the Metrology lecture course at Gdańsk University of Technology. The first cohort (2024/2025) comprised 289 students and the second cohort (2025/2026) comprised 345 students, drawn from three degree programmes: Electronics and Telecommunications (EiT), Automatics, Cybernetics and Robotics (ACiR), and Biomedical Engineering (IBM). Both cohorts completed the same gamified assessment system, with the second cohort experiencing the iteratively refined version described in Section 4.

The primary outcome measure was the total points score achieved by each student across all seven modules of the gamified system, out of a maximum of 40 points. Pass rates were calculated using the thresholds applicable to each cohort: 25 points in 2024/2025 and 24 points in 2025/2026. To contextualise the marginal difference in thresholds, analyses were also examined at the level of score distributions, allowing comparison of overall performance patterns independently of the threshold values. Data were extracted directly from the Moodle learning management system, which recorded each student's cumulative score across all completed modules. No self-reported data are included in the present analysis; all outcome measures are based on objective system logs. Student participation in the gamified format was voluntary in the sense that an alternative traditional assessment pathway remained available; however, the overwhelming majority of students in both cohorts elected to participate in the gamified system.

Comparisons were conducted at two levels: overall cohort performance and programme-level disaggregation by degree programme (EiT, ACiR, IBM). Descriptive statistics were calculated for each group, including pass rates, mean scores, and score distributions across defined intervals. To assess the statistical significance of observed differences, Mann-Whitney U tests were applied to compare score distributions between cohorts, as this non-parametric test is appropriate for ordinal data that cannot be assumed to follow a normal distribution. Chi-square tests of independence were used to compare pass rates between cohorts. Effect sizes were calculated as r for Mann-Whitney U tests and ϕ (phi) for chi-square tests, interpreted according to conventional thresholds: $r > 0.3$ and $\phi > 0.3$ indicate a large effect, $r > 0.1$ and $\phi > 0.1$ a medium effect. The quasi-experimental nature of the design – without random assignment and with a one-point threshold adjustment between cohorts – is acknowledged as a limitation, which is discussed further in Section 7.

6. Results

Table 1 presents a comparison of overall learning outcomes between the two cohorts. Pass rates increased substantially from 72.3% in 2024/2025 to 92.2% in 2025/2026, representing a gain of nearly 20 percentage points. This difference was statistically significant ($\chi^2 = 42.79$, $df = 1$, $p < 0.001$, $\phi = 0.260$), indicating a medium-to-large effect. Mean scores rose from 26.3 to 31.7 points, an increase of 5.4 points on a 40-point scale. The Mann-Whitney U test confirmed that the score distributions differed significantly between cohorts ($U = 24510$, $p < 0.001$, $r = 0.508$), representing a large effect. The minimum score recorded also increased markedly, from 1.97 points in the first cohort to 14.0 points in the second, suggesting that the iterative changes had a particularly pronounced effect on lower-performing students.

Table 1: Overall learning outcomes by cohort

Measure	2024/2025 (n=289)	2025/2026 (n=345)	Change
Pass rate	72.3%	92.2%	+19.9 pp
Mean score	26.3 pts	31.7 pts	+5.4 pts
Min score	1.97 pts	14.0 pts	+12.0 pts
Max score	37.8 pts	40.0 pts	+2.2 pts
Mann-Whitney U (scores)	–	–	$p < 0.001$, $r = 0.508$
Chi-square (pass rate)	–	–	$\chi^2=42.79$, $p < 0.001$, $\phi=0.260$

Table 2 presents results disaggregated by degree programme. The improvement was statistically significant across all three programmes, with no programme showing a decline in either pass rate or mean score. Chi-square tests confirmed significant differences in pass rates for ACiR ($\chi^2 = 6.87$, $p = 0.009$, $\phi = 0.187$), EiT ($\chi^2 = 22.36$, $p < 0.001$, $\phi = 0.273$), and IBM ($\chi^2 = 11.25$, $p < 0.001$, $\phi = 0.288$). Mann-Whitney U tests similarly confirmed significant differences in score distributions for all three programmes (ACiR: $p < 0.001$, $r = 0.515$; EiT: $p < 0.001$, $r = 0.555$; IBM: $p < 0.001$, $r = 0.434$), with effect sizes in the large range across all programmes.

Table 2: Learning outcomes by degree programme

Programme	Pass 24/25	Pass 25/26	Δ pp	Mean 24/25	Mean 25/26	Δ pts	χ^2 (p)	r (MWU)
ACiR	77.9%	92.2%	+14.3	27.2 pts	32.5 pts	+5.3	6.87 (0.009)	0.515
EiT	69.4%	91.6%	+22.2	25.7 pts	31.6 pts	+5.9	22.36 (<0.001)	0.555
IBM	70.2%	93.3%	+23.0	26.0 pts	30.8 pts	+4.7	11.25 (<0.001)	0.434

Beyond pass rates and means, the distribution of scores shifted markedly between cohorts. In 2024/2025, the largest concentration of students fell in the 25–30 point bracket, with relatively few students achieving scores above 35 points. In 2025/2026, the centre of gravity moved decisively upward: a substantially higher proportion of students achieved scores in the 30–40 point range. In ACiR, 46.1% of students scored between 35 and 40 points in 2025/2026, compared to 3.2% in 2024/2025. In EiT, the equivalent figures were 33.1% and 2.8% respectively. The consistency of statistically significant improvement across all three degree programmes strengthens the interpretation that the observed gains reflect a systemic effect of the iterative redesign rather than cohort-specific factors.

7. Discussion

The results presented in Section 6 indicate that the iterative refinements introduced between the two cohorts were associated with substantial and statistically significant improvements in student learning outcomes. The magnitude of improvement – statistically significant across all three degree programmes, with Mann-Whitney effect sizes ranging from $r = 0.434$ to $r = 0.555$ – warrants careful consideration of which design changes may have driven the observed gains.

Three mechanisms may account for the observed improvements, corresponding to the three principal changes introduced for the second cohort. The addition of optional practice tests is the most straightforward candidate explanation. By providing students with a low-stakes opportunity to engage with question formats and content prior to graded assessment, the practice tests likely reduced test anxiety and improved preparedness – effects well documented in the formative assessment literature (Hattie and Timperley, 2007; Nicol and Macfarlane-Dick, 2006). The pronounced rise in minimum scores – from 1.97 to 14.0 points – suggests that this intervention was particularly beneficial for students who had previously struggled to engage productively with the system, consistent with research indicating that scaffolded preparation disproportionately benefits lower-achieving learners.

The narrative easter egg content may have contributed to sustained engagement across the full semester. Whereas point accumulation alone can lose motivational potency over time – a phenomenon sometimes referred to as hedonic adaptation in the gamification literature – narrative rewards offer a qualitatively different incentive that does not diminish with repetition (Nicholson, 2015). The discovery-based structure of the easter eggs, visible only to students who successfully completed the Care Phase, may also have reinforced the perceived value of full engagement rather than minimal compliance. The accompanying motivational feedback messages for students who did not unlock the narrative content – framing non-completion as a recoverable state rather than a failure – are consistent with autonomy-supportive feedback principles (Deci and Ryan, 2000) and may have reduced disengagement in the lower-performing segment of the cohort.

The technical refinement of the Task/Mission selection mechanism, while seemingly minor, may have reduced friction at a critical decision point. Research on choice architecture suggests that even small improvements in interface clarity can have disproportionate effects on user behaviour (Zichermann and Cunningham, 2011),

and the Care Phase selection represents the moment at which students commit to a level of challenge – a decision with direct consequences for their final score.

A further consideration for practitioners concerns the long-term viability of iterative gamification design. The refinements described in this paper – developing narrative easter egg content, creating practice tests, and improving the task selection interface – required a moderate investment of time by the course instructor between academic years, without necessitating additional staffing or infrastructure. The narrative content in particular requires periodic renewal to maintain its novelty for students who may have discussed it with peers from previous cohorts. However, given that the system operates entirely within an existing learning management system (Moodle), the recurring costs are primarily those of instructor time rather than financial resources, suggesting that this approach is sustainable within typical academic workloads.

Several limitations of the study warrant acknowledgement. The quasi-experimental design does not permit causal attribution: the observed improvements may reflect cohort differences, broader institutional changes, or other unmeasured factors rather than the specific redesign elements. The one-point reduction in the passing threshold between cohorts, while marginal given the magnitude of the observed effect sizes, introduces a minor confound. Furthermore, the absence of a control group means that maturation effects and increased student familiarity with the format cannot be fully excluded. The relative contribution of each individual design change cannot be determined from the present data, as all three modifications were introduced simultaneously.

Nonetheless, the consistency of large effect sizes across three degree programmes with distinct student profiles provides meaningful evidence against a purely cohort-specific explanation. Future research should examine the relative contributions of individual design changes through controlled conditions, and should incorporate student-reported data on motivation, perceived difficulty, and narrative engagement to complement the objective outcome measures reported here.

8. Conclusion

This paper presented a two-year comparative study of an iteratively refined gamified assessment system implemented in a large-scale engineering course at Gdańsk University of Technology. Across 634 students from three degree programmes, the introduction of optional practice tests, narrative easter egg content, and technical interface improvements between the first and second cohort was associated with statistically significant and practically substantial improvements in learning outcomes. The outcome data showed substantial and statistically significant improvements across both cohorts, and score distributions shifted markedly upward, with large effect sizes observed both overall ($r = 0.508$) and across all three individual programmes ($r = 0.434$ – 0.555).

The findings contribute to the growing body of evidence supporting gamification as an effective approach to assessment design in higher education, while adding a dimension that remains underrepresented in the literature: the value of closing the feedback loop between students and course designers. The improvements observed here were not the result of designing a new system from scratch, but of listening systematically to the first cohort and making targeted, evidence-informed adjustments. This iterative approach is replicable and scalable, requiring no additional infrastructure beyond the learning management system already in use.

The study also demonstrates that high levels of student engagement and strong learning outcomes can be achieved without social comparison mechanisms such as leaderboards or peer rankings. Motivation in this system was driven by individual challenge, narrative immersion, autonomy in task selection, and the intrinsic satisfaction of progressive achievement – a combination consistent with Self-Determination Theory (Deci and Ryan, 2000) and with Nicholson's (2015) framework for meaningful gamification.

For practitioners in engineering education and beyond, the key implication is straightforward: gamified systems should not be treated as finished products after their first implementation. Systematic collection and application of student feedback – even when it leads to modest design changes – can yield substantial improvements in both pass rates and overall performance levels. The present study suggests that the feedback-to-features pipeline is among the most effective tools available to course designers working within existing institutional constraints.

Future work should investigate the relative contributions of individual design elements through controlled experimental conditions, incorporate qualitative and self-reported data on student motivation and narrative

engagement, and examine whether the improvements observed here are sustained or further amplified in subsequent cohorts.

Ethics Declaration: This study did not require ethical clearance. The data used in this research were extracted from the Moodle learning management system as aggregated score records. No personal data, identifiable information, or data collected outside the normal course of teaching were used in the analysis.

AI Declaration: Claude (Anthropic) was used in the preparation of this paper as a language checking and editing tool. All research design, data collection, analysis, interpretation, and academic content are the work of the author.

References

- Babicz, S. (2025) *Comparing Learning Outcomes in Traditional and Gamified Lecture Formats*, in Proceedings of the 15th International Conference The Future of Education, Filodiritto Editore, pp. 508–513. doi:10.26352/l625_2384-9509
- Buciuman, C. F., Potra, S. and Dungan, L. (2024) *Integrating Agile Methodologies and Gamification for Student Engagement and Success*, In Proceedings of the 18th European Conference on Games Based Learning. Academic Conferences and publishing limited. doi:10.34190/ecgbl.18.1.2766
- Biggs, J., Tang, C. and Kennedy, G. (2022) *Teaching for Quality Learning at University*, McGraw-Hill Education, London.
- Caponetto, I., Earp, J. and Ott, M. (2014) *Gamification and education: A literature review*, Proceedings of the 8th European Conference on Games Based Learning, pp. 50–57.
- Clifford, M.M. (1988) *Failure tolerance and academic risk-taking in ten- to twelve-year-old students*, British Journal of Educational Psychology, Vol. 58, No. 1, pp. 15–27.
- Deci, E.L. and Ryan, R.M. (2000) *Intrinsic and extrinsic motivations: Classic definitions and new directions*, Contemporary Educational Psychology, Vol. 25, No. 1, pp. 54–67.
- Deterding, S., Dixon, D., Khaled, R. and Nacke, L. (2011) *From game design elements to gamefulness: Defining gamification*, Proceedings of the 15th International Academic MindTrek Conference, Tampere, pp. 9–15. doi:10.1145/2181037.2181040
- Díaz-Ramírez, J. (2020) *Gamification in engineering education: An empirical assessment on learning and game performance*, Heliyon, Vol. 6, No. 9. doi:10.1016/j.heliyon.2020.e04972
- Dichev, C. and Dicheva, D. (2017) *Gamifying education: What is known, what is believed and what remains uncertain*, International Journal of Educational Technology in Higher Education, Vol. 14, No. 9. doi:10.1186/s41239-017-0042-5
- Hattie, J. and Timperley, H. (2007) *The power of feedback*, Review of Educational Research, Vol. 77, No. 1, pp. 81–112. doi:10.3102/003465430298487
- Ibanez, M.B., Di-Serio, A. and Delgado-Kloos, C. (2014) *Gamification for engaging computer science students in learning activities: A case study*, IEEE Transactions on Learning Technologies, Vol. 7, No. 3, pp. 291–301.
- Kapp, K.M. (2012) *The gamification of learning and instruction: game-based methods and strategies for training and education*, John Wiley and Sons, San Francisco.
- Landers, R.N. (2014) *Developing a theory of gamified learning: Linking serious games and gamification of learning*, Simulation and Gaming, Vol. 45, No. 6, pp. 752–768. doi:10.1177/1046878114563659
- Nicol, D.J. and Macfarlane-Dick, D. (2006) *Formative assessment and self-regulated learning: A model and seven principles of good feedback practice*, Studies in Higher Education, Vol. 31, No. 2, pp. 199–218. doi:10.1080/03075070600572090
- Nicholson, S. (2015) *A recipe for meaningful gamification*, in Reiners, T. and Wood, L.C. (eds.) *Gamification in Education and Business*, Springer, New York, pp. 1–20. doi:10.1007/978-3-319-10208-5_1
- Zichermann, G. and Cunningham, C. (2011) *Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps*, O'Reilly Media, Sebastopol.