GAMIFICATION, STANDARDS AND SURVEILLANCE IN MATHEMATICS EDUCATION: AN ILLUSTRATIVE EXAMPLE

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There has been an impressive growth in the number of online games and apps for mobile devices, which attempt to integrate school type mathematics tasks into game environments. These are based on a pedagogic tactics that is often referred to as "gamification". This paper looks at gamification from a perspective that draws on Foucault's ideas of surveillance and normalisation. It explores the pedagogic discourses promoted by gamification, how the mathematics learner and teacher are constituted, and how records of students' conduct and performance may potentially be incorporated into larger infrastructures of accountability. One example of a "serious game" is analysed in detail with a focus on how the game regulates student players, what forms of assistance for self-discipline or self-awareness are promoted, and what micro-strategies of normalisation may emerge.

GAMIFICATION

Surveillance and normalisation are central in education. School mathematics discourse that is based on curriculum standards inevitably attempts to categorise the learners in terms of their performance in relation to what "normally" is expected, which creates both, criteria for what it means to be successful in mathematics and students who achieve below and above a minimum standard or at a range of levels. As then there are always students with low marks, grades, or test scores as well as a range of "truths" for explaining the reasons for their low attainment, there are also a range of pedagogic tactics for overcoming what for instance is framed as "lack of engagement", "emotional disturbance", "behavioural problems", or "lack of scholastic aptitude". What has become known under the label "gamification" is a comparatively recent example of such tactics.

Gamification strategies for developing so called "serious games" (Ulicsak and Wright, 2010) are based on tracing data produced by the user that are reworked into feedback (that may include numbers and diagrams) in order to modify their action. The production of this feedback may include voluntarily or unwittingly contributing their data into connected databases, which can be searched for patterns within groups or populations (McRae, 2013; Zuboff, 2013a). Gamification combines this mode of surveillance with design features and mechanisms taken from computer games, such as 3-D virtual environments seen from a first-person "shooter-perspective", surprises to increase attention, fast-paced game environments that demand quick responses, beeping sounds, partly self-designed avatars, an overall narrative about a mission to be accomplished, level-ups, and badges (DeBurr, 2013; Kebritchi, 2008; Whitson, 2013).

Gamification includes the introduction of a “token economy”. Intervention programmes based on a token economy were developed in the 1960s and disseminated in the 1970s for disciplining psychiatric patients, prisoners, juvenile delinquents, or “disadvantaged” primary school children (Kazdin, 1982). These interventions make use of the idea of operant and conditional reinforcement; accordingly, research articles include reports about the successful functioning of token economies with rats (Malagodi, 1967) or chimpanzees (Sousa & Matsuzawa, 2001), where exchangeable tokens and food were comparable in reinforcing behaviour. In hospitals or educational institutions the reward consists of the opportunity to engage in activities that are chosen by many when freely allowed, with the tokens used to bridge the delay between the adaptive behaviours for functioning in the institution and that opportunity. Subjects exposed to this treatment are expected to “purchase” the activity with their tokens and consequently to engage in token-earning behaviours (Kazdin, 1982). This “economy”, however, where the tokens may be interpreted as wages for the labour of engaging in adaptive behaviour, is obviously restricted as there is no choice on the side of the presumed pleasure-seeking “consumer” who pays for activities they are already entitled to pursue in the institution.

In contrast to these examples of token economies, in gamification playing the game itself functions as the activity assumed to be chosen over others when freely allowed; and the collected tokens (such as points and level-ups) are exchanged against other rewards only in the virtual setting. If aimed at controlling the acquisition of skills, “cascading information” by de-composition into a series of steps, which is one aspect of the gamification tactics, is clearly inherited from behaviouristic learning theories in addition to the use of quests and reinforcement. In companies, gamification is employed for increasing efficiency by means of controlling the emotions of employees, such as the motivation to work overtime via engagement in multiplayer games for training purposes or finding problem solutions under surveillance of the management. The absence of “punishments” as well “key performance indicators” in relation to an overall task function as techniques of “disciplinary power” (in the sense of Foucault, 1977), often visualised as percentages, traffic light colours or charts.

The features described above are also included in the gamification of acquisition of skills in educational contexts, as for example in online games and apps for mobile devices, which attempt to integrate school type mathematics tasks into game environments. The idea of course is not new as the use of computer or calculator “games” in school mathematics has already been promoted in the 1970s. The concomitant knowledge discourses concentrate on their benefits with a focus on the games’ production of favourable affects, such as increased motivation and positive attitudes (Bragg, 2007). In addition, playing mathematics-related games has been reported to affect some achievement measures (e.g., Kebritchi et al., 2010, and Kolovu et al., 2013, cited in van den Heuvel-Panhuizen, Kolovou, & Robitzsch, 2013).

While unmediated surveillance is essential in classroom practice (e.g., Walshaw, 2010), gamified surveillance tools often provide functions for (hidden) observation and record-taking of students' conduct and performance and their potential incorporation into larger infrastructures of accountability. In Foucault's (1994) conception of surveillance, the possibility of observing others only implies power if they "use their own presence in order to watch over others" (pp. 349–364). The former may not be the case when students work on-line and access different sites, even if they are in the same physical space. Advancement in technology, however, offers "opportunities to monitor students while working online" (van den Heuvel-Panhuizen et al., 2013, p. 285). Not only student performance data during online gaming can be surveilled and stored, but also process aspects of their behaviour.

The example analysed in this paper is typical with regard most of the features that are central in gamification tactics. It is designed for primary school teachers, students, and their parents. Notably, gamified mathematics pedagogy is not restricted to (primary) school. Kallweit and Griese (2014) present an example that has been used with first year engineering students, who are portrayed as lacking the ability to autonomously organise their (mathematics) studies.

EXAMPLE: "LEARNING ENGINE"

The label 'Learning Engine' is part of the subtitle of a site entitled 'Sumdog', which contains 'games' and a 'progress hub': "Our new learning engine for the National Curriculum in England, Years 1–9"

The analysis of this example was part of an earlier presentation (Jablonka & Bergsten, 2016). As empirical data we used information about the features of the tools and associated knowledge discourses, such as promotion videos, 'witnesses' (teachers or students) and texts aiming at an academic audience, if available. We also used our reading of the texts (in the widest sense) this game produced while we were engaging with it in the role of students and teacher. We interacted with the free version of the site by setting up a 'school-class' with three students and a teacher.

Promotion discourse: fluency, achievement reports and happy students

School mathematics is configured as a set of skills, in which students acquire "fluency". The system is portrayed as an agent that can read the traces produced by each individual student-player during the games. The system is also said to be able to rework these traces into numbers and display speed, accuracy and time spent, "proficiency charts", "improvement charts", "maths reports" and "diagnostic test reports", numbers for "top five students", and "class reports" in relation to progression in standards:

"It [the system] gets to know each student, leading them through the standards, and reports their progress to their teachers", "building a precise picture of their fluency", "skill by skill, and day by day" and "can tell that the whole skill is mastered."

In addition to a teacher being eager to get quantitative reports about each student's 'progress' with regard to 'standards', the system also suggests a teacher who is interested in live-surveillance, as they can log in "while your students play, and you'll see their scores live on your dashboard. The live data is great for pinpointing students who are working well, or those who need a little help."

Another promotion topic is the production of happy students: "We turn fun into fluency, Happy students learn more". Due to absence of direct teacher surveillance "students have a great time—but their teachers retain control over their work" while they perform an activity called "play" or "game" or "diagnostic testing...while students play".

In addressing the students, the fun is attached to making it "easy": "Every few games, to keep things fun, you'll take a break, and revise skills you've already mastered." Furthermore, there is a 'natural' category of student who invests effort, which apparently is a moral virtue to be rewarded, but does not necessarily lead to progress: "For the first time, we're rewarding progress as well as effort. Click your pet to see the tricks it has learned, and then choose one to play it."

Practices and discourses within the games

To proceed in a game the player has to answer multiple-choice mathematics questions that suddenly appear on the screen. The games, however, point at a mix of different practices and discourses at different levels of interaction with the site.

Computer or console games. The games' opening images and names (e.g., cake monsters, pop tune, junk pile, soccer, submarine, dress town) hint at their apparent main action. Some (only superficially) resemble some simulation of an activity outside the game; most scenarios are fantasy.

Each player battles in real time three other players currently inside, either from the class or the "world", or plays against a selected robot at a particular mastery level (e.g., "challenger" or "destroyer"). One feature these games share with multiplayer online-games is that players can select and partly compose (gender, skin colour, hair style, etc.) an avatar in the form of an image of a person. The players cannot, however, choose their name as these are set by the teacher and are displayed beside the avatar image, in addition to their school name.

Selection of the correct answer is rewarded with a 'coin' across all games and in many games linked to a repetitive action that relates to the title of the game (e.g., flicking a ball into a goal, balancing junk falling from the sky on a growing pile, feeding monsters with pieces of a raising cake). These skills contribute to the game-score. There is game-style background music and sounds evaluating the skills in the activity (e.g., making a goal or not when flicking a ball towards in the game 'soccer'). Furthermore, there is some element of chance responsible for variation in the fluid animation of the activity and occasionally there comes a bonus (e.g., an extra kick etc.). After each game, a ranking of all four players appears. The player can also look at their own ranking in relation to the scores achieved by the friends' best, class best and the world's best.

The player's action does not change any part of the unfolding scene except the invisible 'level' of the mathematics tasks presented and does not have any bearing on the other players' course of action. Given this rather closed nature of the games, there is not much room for freedom of inventing interesting ways of engaging with the scene. The activity establishes children as more or less proficient individual computer game players, who find some pleasure in accumulating 'coins' and enjoying the sounds, badges, scores, and images that associate appreciative evaluation of a mastery of isolated arbitrary repetitive skills, such as shooting monsters, balancing a pile, flicking a ball, and hitting the goal. The children are in competition with a virtual community of changing school students or their classmates who play the same game and against whom they will be ranked, with a new chance in each game to be ranked first.

School mathematics and diagnostic testing. The mathematics tasks appear on the screen in written form as multiple-choice (four alternatives) in front of the animated scene (mostly top or bottom of page). The type of tasks changes in relation to the number of correct answers selected in previous tasks, clearly recognisable as ranging from recognition of number words and small set cardinality, basic arithmetic and geometry, to elementary algebra and reading simple representations of statistical data. The tasks were mainly about procedures (some quite technical—such as selecting the correct long division); only very few included some interpretation (e.g., place value, comparing fractions, simple 'word problems').

The player initially plays a couple of games to enable the identification of a 'level', if the teacher has chosen this feature. The machine announces, "We are finding your level" and some animals in a still image explain in speech balloons that the students should play games as they always do, promise a pet and a free picking of skills to work on as soon as the test is finished; the animals also advice to guess if you do not know the answer. It is also stated (in a smaller font at the bottom of the page), "teachers and parents can return the test if your level is wrong". When playing in training mode, the system occasionally also gave commands, such as "Eva: keep practicing your tables. See your progress here", or "Congratulations, you have finished a skill." Indeed, one can look up visualisations of the number of correct answers ('progress') in a range of mathematics skills.

Here each child is constructed as being on a level associated with an examination about answering the mathematics tasks, a level that remains hidden to them but can be checked by their teachers or parents. Their examination outcome is derived from training and answering multiple-choice questions as quickly as possible under distractions. The interaction with the system establishes a relation with the computer-examiner that produces reports independently from one's teacher (although with their teacher/parent still keeping some authority).

Earning, shopping and trading in a token economy. The tokens are virtual coins earned for correct solutions of mathematics tasks. Accumulated coins translate into the player's rank name (a species' name). This rank is independent from the curriculum mathematics 'level' identified by the system at which one is made to play. These coins can be used for buying furniture for the room the avatar inhabits, outfit for the avatar, or gifts for a player-friend. Bought items can be resold for a given lower price. This more stable rank constructs a child-consumer with a level of wealth achieved by effort, with wealth of other players being visible through their rank-name. For example, a player at level-1 is a Common Rat; the skilled player proceeds in order of decreasing estimated population of the name-giving species towards a the highest rank of Baiji (level-31). When searching the web, one also finds an informal community of hackers and cheaters who propose tactics for quickly maximising coins in the game.

Social media. One can join a family (when parents sign up) and be-/defriend other players; yet, one cannot communicate with them. From the system one receives messages that congratulate to a "level-up" regarding the wealth-rank.

Normalisation and surveillance: double standards and wishful identification

In the game there are two layers of competition and normalisation, one open and visible and the other covert. The first is derived from the gaming actions and the second from solving the mathematics tasks. Hence the game establishes two categories of player: a child-player and a student-player.

For the child-player there are fluid relative categories in terms of the ranks achieved in the games from defeating other players and the levels-up from accumulating coin tokens. But these are independent of the invisible mathematics curriculum 'level' and the performance profiles of the student-player, only visible to the teacher or parent. As the child-player performs the avatar's mathematical action as a student identifiable by the teacher, the mathematical game-performance and associated subject position is not short-lived, but incorporated into school performance, and becomes part of it.

The avatar may provide an escape exactly from a 'real' low level reported to the teacher offering the vicarious experience or wishful identification with the wealth earned by extensive playing with a high number of correct solutions, even when being at a low 'real' mathematics skills level. The construction of the mathematics student-player works via the invisible ranker's eye on their own and the other players' mathematical skills.

Both as a child-player and student-player they are objectified as sources of data for the calculation of performance profiles, because in the game there are no choices that influence the outcomes or actions of the other players other than correctly answering the tasks, which pop up in an order to the principles of which the player has no access.

Naturally, it is difficult to know the nature of the children's awareness of being surveilled. When clicking 'parents/teachers' they can read that the page is for teachers and parents only and they will not be able to "use the tools on this page". But they can still see the categories (Live Data, Assessments, Contests, Reports). In addition, there is an example for teachers and parents on 'live Accuracy Data', which shows a table with student names and percentages ranked in decreasing order, some with green and other with red dots.

DISCUSSION

As illustrated by means of the example, the 'gamification' of mathematics skills acquisition creates a hybrid of a range of practices and discourses. The game intends to use seduction as a tactics for controlling the emotions of the child-player in order to regulate the student-player's allegedly unpleasant mathematical activities. This discourse conditions a particular way in which fun is related to school, or 'playing' a multiplayer online-game to 'learning mathematics'. Individual competition within a logic of out-doing of one's own previous performance and that of others in terms of quantitative metrics (speed, number of tasks, coins, levels) is the basic principle for the construction of the "game", which appears strongly regulated. The gamification tactics, however, follows the same selling point in establishing an opposition to something that is not fun as found in other pedagogic discourses that focus on "play". Yet, gamification has little to do with the pedagogic discourse Bernstein (2000) saw associated with play, based on the re-emerging liberal romantic philosophy of education and developmental psychology, which he referred to as competence model (as opposed to a performance model). For the gamification in the learning engine is not based on psychological theories of cognitive development, but on behaviouristic psychology. Despite the apparent emphasis on the subject as self-regulating, the focus is on absences of performance in relation to standards and the requirements for accountability. This and similar games may be seen as a development of "Learning Machines", such as those by Pressey (1926) and Skinner (1954). In contrast to these early attempts of constructing learning machines, however, an explicit management of feelings, motives, and intentions is included in this new surveillance.

As McRae (2013, n.p.) observes, a new generation of more sophisticated adaptive learning systems "still promote the notion of the isolated individual, in front of a technology platform, being delivered concrete and sequential content for mastery". According to McRae, this type of platforms not only provokes a revival of behaviourism in education but also facilitates data accumulation by large corporations involved in their development. "At its most sinister, it establishes children as measurable commodities to be cataloged and capitalized upon by corporations" (McRae, 2013, n.p.). This development reflects what Zuboff (2013b) refers to as surveillance capitalism.

By the machine's calculations, the game-performance of a range of mathematics skills is transformed. In contrast to classical 'performance models' (in Bernstein's

2000), the teachers cannot easily read or interpret the performance without the machine. The categories for students at different 'levels' are initially empty. Only with the help of the machine the 'levels' are interpreted in qualitative terms in a discourse about progress in standards, which Llewelyn (2015) sees in the discursive space of educational policy as producing the 'normal' mathematical child as a functional automaton. Neither the players nor the teacher are aware how mathematical relations materialise in the machine and have been used as a resource for programming the game and for producing reports.

Whitson (2013) argues that with the aid of new surveillance technologies which enable recording and linking of different bodies of big data, 'gamification' fosters a "quantification" of the care of the self (Foucault, 1988) "enabled by increased levels of surveillance (self-monitoring and otherwise)" in projects that use "incentivisation and pleasure rather than risk and fear to shape desired behaviours" (p. 167). But as argued above, the forms of incentives and reinforcement used by gamification tactics conceive the subject in entirely behaviouristic terms. Furthermore, as illustrated by the example of the "learning engine", the accumulated data about the individual student-player remains largely hidden from them as child-player but are subjected to the displaced teacher's gaze. This constellation then is a panopticon without disciplinary power (in the sense of Foucault, 1977), and dissociated from the direct control of space and time.

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